MACHINERY

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MACHINE STOPS, TRIPS AND REVERSING MECHANISMS

By JOSEPH G. HORNER*

IN recent years, stops, trips and reversing mechanisms have been applied to a vast number of machine tools. The stops employed vary from the simple adjustable stop, tappet or dog, to the mechanisms in which these are combined with cushion devices, means for reversing feed movements, etc.

It may be advisable at the outset to call attention to the difference between a "self-acting" and an "automatic" movement. Many machines which are not wholly automatic contain self-acting movements. A slide-rest is self-acting, though the lathe is not automatic, because the movements of the slides have to be thrown in and out by the operator. The greater number of turret lathes are semi-automatic or self-acting, as distinct from the automatic or "full automatic" screw machine. A number of gear-cutters and grinders, in which all the movements proceed without intervention from the attendant, are also in the class with the fully automatic machines. It is in these classes of machines that the highest developments of the mechanisms to be considered are found.

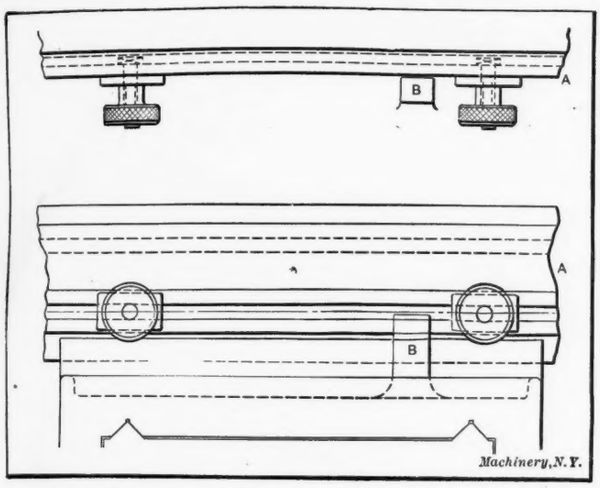

Fig 1. Dead Stops of a Type used on a Cutter-grinding Machine

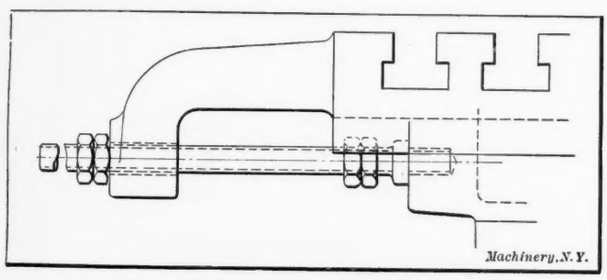

Fig. 2. Efficient Type of Stop-rod for Turret Lathe Cross-slide

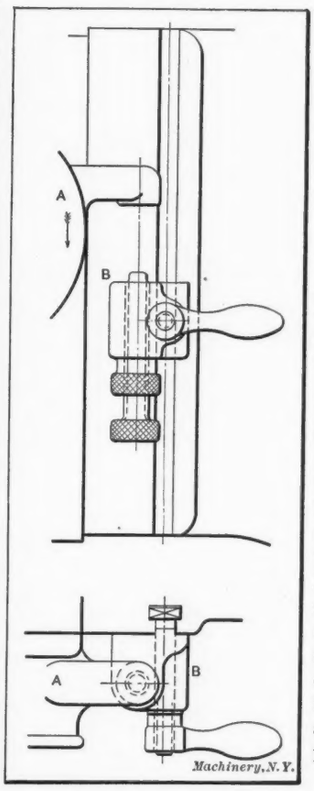

Fig. 3. Dead Stop used on a Vertical Milling Machine

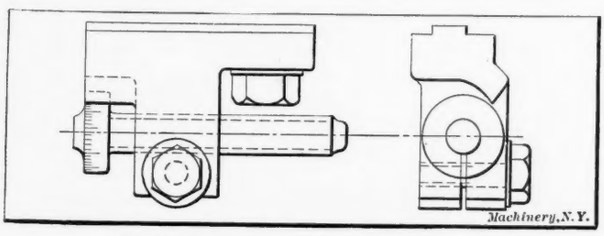

Fig. 4. Stop-screw with Micrometer Adjustment

There are two kinds of stops: "Dead" stops are those which positively arrest a movement, and gage a length or diameter in repetitive work; "trip" stops or "trips" throw out a movement, reverse it, or throw it in again. Dead stops alone are not sufficient to check a power feed or self-acting movement; some means must also be provided to throw out the feed. Then a dead stop may or may not be incorporated to form a positive check. In many cases the tools themselves, as in some turret-lathe work, constitute dead stops, and render the provision of additional stops unnecessary. A dead stop is used in hand-operated mechanisms to prevent the operator from moving the slide or other portion further than the predetermined limit, thus guarding against error, and insuring a duplication of dimensions without the need for measurement or gaging. Again, it is often possible to throw out a dead stop temporarily, and go past it for certain purposes, such as inspection, and again throw it in at the same setting as before. A number of dead stops may be located close together, to enable selection to be made at will or in regular rotation, as in the case of a turret—one for each tool-hole. Frequently duplex stops are arranged, to enable the choice of two distances for a single slide, one stop being thrown out of the way. Fine adjustment is in some cases provided for a dead stop, so that a very precise setting can be obtained.

An important point in the design of dead stops is that of rigidity; a solid abutment should always be used, and any excessive overhang tending to cause springing must be avoided; otherwise accurate results are impossible. In the operation of a hand turret lathe or other machine tool there is necessarily a great deal of banging and rough treatment, especially in the hands of a careless operator, and weak and badly-supported stops will cause unsatisfactory work. The binding arrangement for a stop must also be efficient, so that it will not slip and cause a batch of work to be turned out to wrong dimensions. The hardening

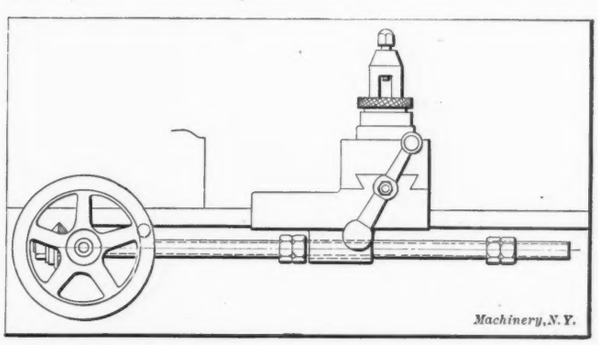

Fig. 5. Stop-rod passing through a Hole in a Turret Lathe Cross-slide

* Address: 45 Sydney Buildings, Bath, England.

of contact surfaces is also advisable for preventing wear and bruising that would affect the dimensions of work produced.

The position and method of attachment of a dead stop depends on the class of machine and the design. Where a sliding table has to be stopped, it is in many cases possible to attach the stops or dogs by means of a bolt and T-slot in the edge of the table, this being a very simple method and permitting easy adjustment; or a round rod may be held in bearings on the edge of the table, and adjustable dogs be clamped to the rod by set-screws, or by split ears or lugs. Another method is to have a fixed stop bolted to the table edge, and adjustable dogs attached to a rod in front, these being struck by the stop according to the movements of the table. A

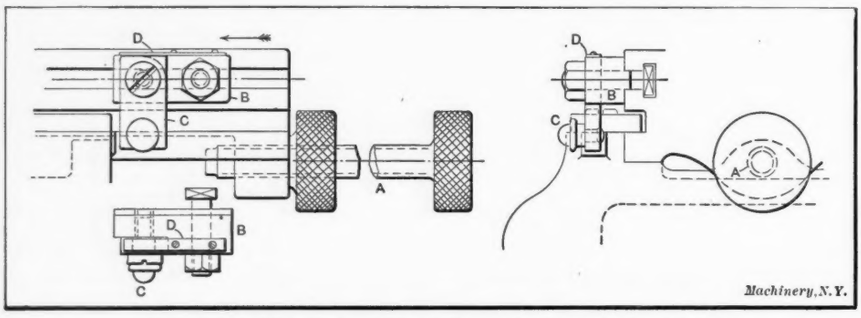

Fig. 6. Double Stops used on Turret Lathe, making it possible to obtain Two Lengths without the Necessity of readjusting the Stop-screw

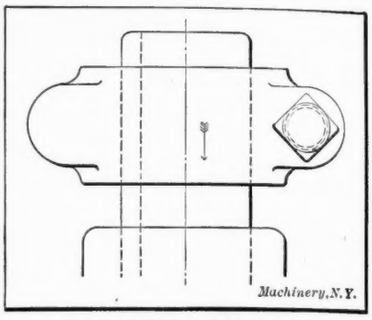

Fig. 7. Split Stop Collar used on Drill-press Spindle

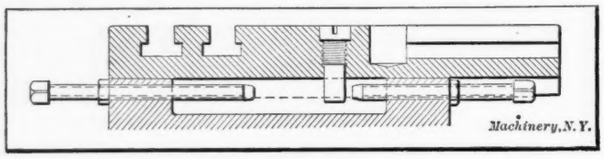

Fig. 8. Double Dead Stops

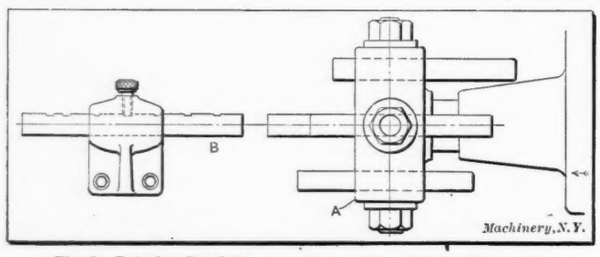

Fig. 9. Rotating Dead Stops used on a Turret Lathe Cross-slide

favorite device for short slides, such as the cross-slides of turret lathes, is to attach the stops to a rod or screw passing through a hole in the slide, the faces of the latter coming into contact on each side alternately with the stops. Plain cylindrical parts, if of small diameter, are often controlled by a collar or lug, clamped to them by means of a set-screw, and arranged to encounter the face of the bearing through which the part moves.

It is evidently impossible to show all the different kinds of stops which are in use on various machine tools, but the following selection of typical examples embodies the principles involved in the design of all stops. Slight modifications in form and location are made in different machines.

In Fig. 1 is shown the simplest possible kind of dead stop applied to the table of a cutter grinding machine. We have here a T-slot in the edge of the moving table *A*, receiving the heads of the bolts which clamp the two stop-plates through the medium of knurled nuts. The plates strike the block *B* on the transverse table.

Fig. 3 shows a modification of the same principle. In this case the sliding head *A* of a vertical milling machine is to be stopped in one direction only—the downward—and a projection stands out from the slide *A* to encounter the end of the stop-screw in the block *B*, which is clamped in a T-slot on the fixed head. After adjusting *B* approximately in position up or down in the slot, by the lever, the final adjustment is made by the knurled-headed screw, which is finally locked by its nut. The screw does not, however, provide a precise means of setting to any exact measurement. In some cases, therefore, such a stop-screw has a micrometer adjustment, Fig. 4. The head of the screw is graduated, so that the screw can be adjusted by a known amount—a manifest advantage in fine work. The body of the stop is split, thus providing positive means for binding the stop-screw.

An illustration of the stop-screw or rod passing through a hole in the moving slide is shown in Fig. 5. The example shown is that of a cross-slide of a turret lathe. The stop-screw in this case also serves the purpose of moving the rest along through the medium of the handwheel and the miter gears; frequently, however, a separate plain rod is used, parallel with the screw, and carrying split clamped dogs instead of the double lock-nuts, shown in Fig. 5. Another example of the use of double nuts is shown in Fig. 2, illustrating the rear end of a cross-slide for a turret lathe. The stop-screw is tapped into the fixed slide, and passes through an extension on the moving slide. This arrangement serves as a stop for both front and back tools. In modification, Fig. 8, two screws are used locked with nuts, the ends of the screws being struck by a pin screwed into the moving slide. The advantage of both these designs of stops is that they are perfectly central, and are therefore better than those classes of stops which are set at the side of the moving slide.

The combination of two stops, to provide the choice of two lengths, is common. A case of this kind is shown in Fig. 6, showing the rear end of a turret slide. The main screw *A*,

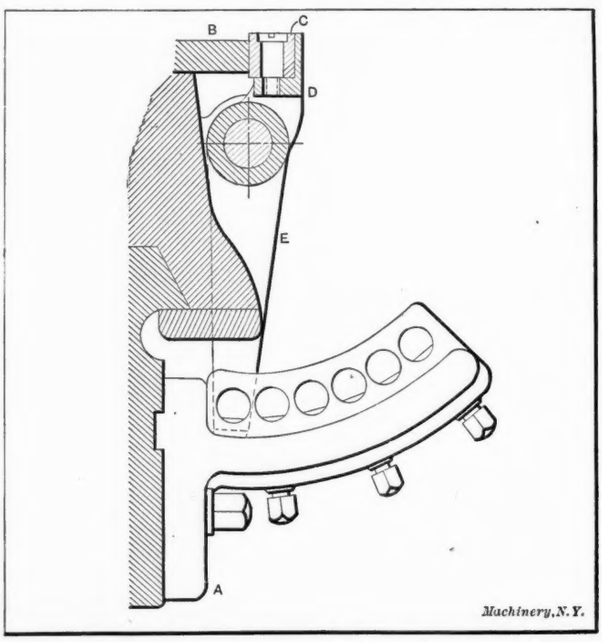

Fig. 10. Turret Lathe Stops used on the Pratt & Whitney Turret Lathes

with a locking nut, abuts against the back of the saddle or base, and forms one dead stop. An adjustable block *B*, bolted to the edge of the slide, carries a pivoted dog *C*, which when dropped down into the position indicated in the view to the left, strikes against a facing on the back of the base. A flat spring *D*, screwed to *B*, presses against the tail of *C* and main-

tains it in position. If *C* is not required, it is swung up into the horizontal position, where the flat spring also retains it.

A simple kind of stop for round spindles is shown in Fig. 7. The example shown is used on a sensitive drill press, and consists only of a split collar, which arrests the downward travel of the spindle by striking against the top bearing.

One of the most valuable principles in stop construction is that of the rotary disk carrying several stops, any of which

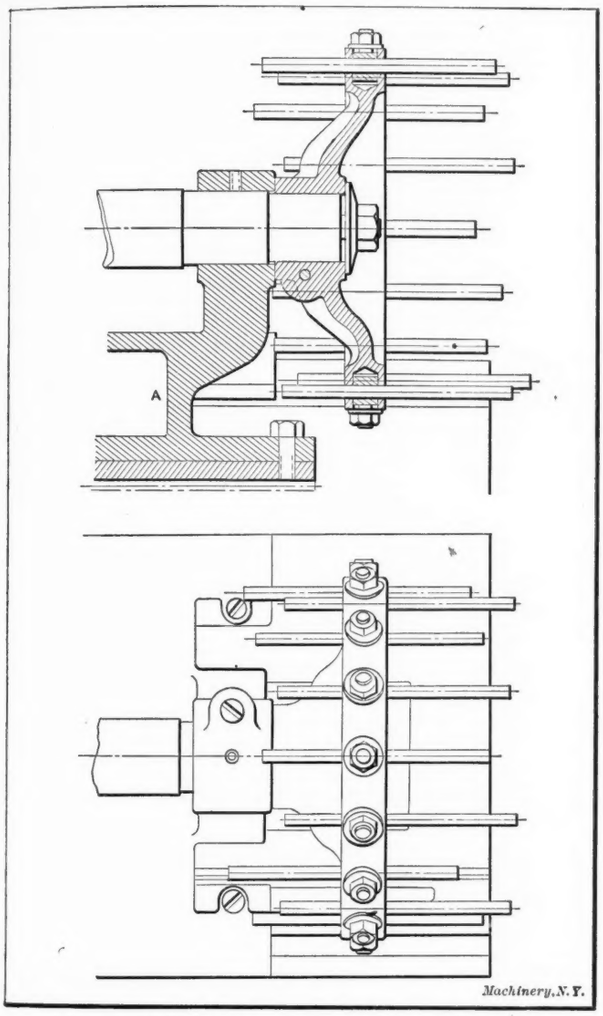

Fig. 11. Dead Stops used on a Turret Lathe of German Make

may be brought into action, either in a selective manner—that is, according to the wish of the operator—or in automatic fashion—one or more stops being made to act only for

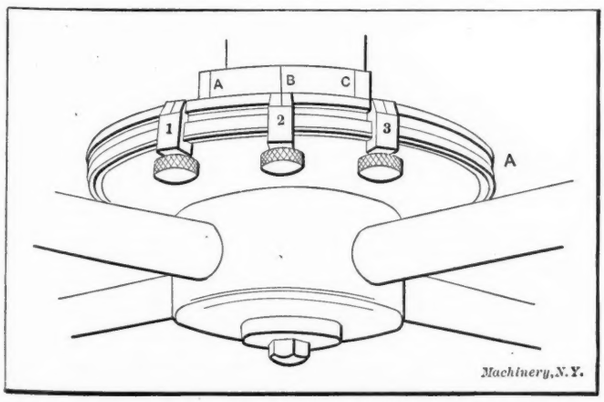

Fig. 12. Enlarged Detail of the Indicator of the Device shown in Fig. 13

a particular tool or set of tools. In this way compactness is secured, and the stops are in full sight and easily accessible, which was not the case with some of the older designs of multiple stops, such as, for example, a set of flat bars laid side by side and used for turret stops. Fig. 9 illustrates a rotating type of stop, adopted for the cross-slide saddle of the turret lathe, there being one stop-rod for each tool on the cross-slide turret. The head *A* is mounted on the end of a

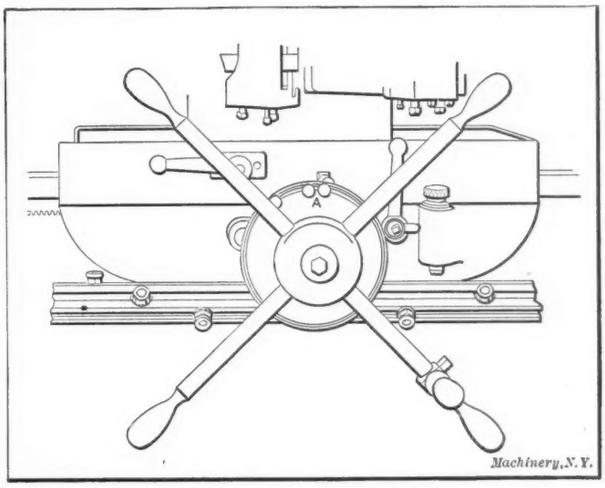

Fig. 13. Rotating Stop-bar and Accurate Indicator used on the Alfred Herbert Hexagon Turret Lathe

shaft that is rotated simultaneously with the turret, and each of the stop-rods is adjusted independently and secured with a nut, the rod passing through the body of the bolt. Each rod in turn abuts against the bar *B*, held in a bracket bolted to the front of the lathe bed. The adjustment of this bar is effected by loosening the set-screw and sliding it through the bracket;

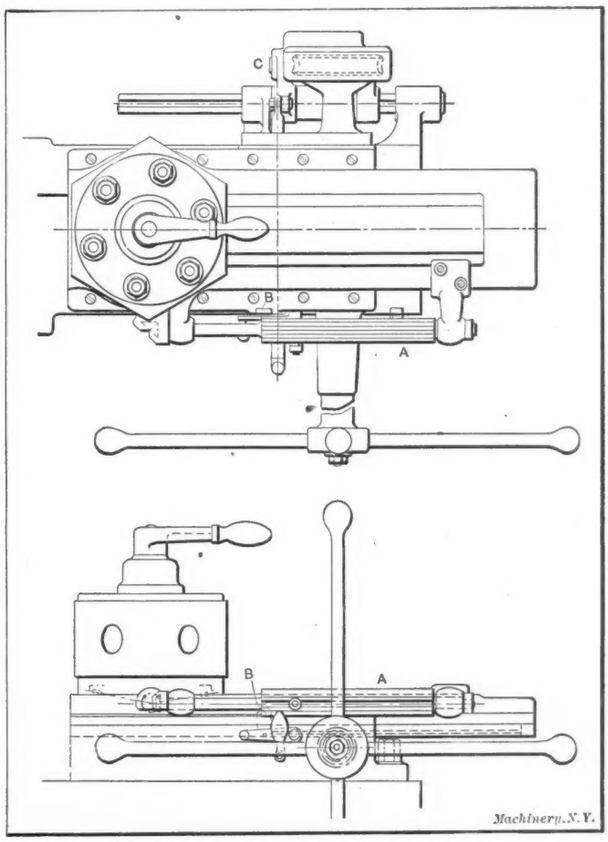

Fig. 14. Rotating Stop-bar used on Turret Lathe

on tightening the set-screw, it bears down on a flat milled on the bar, and forms a positive check to slipping.

Another application is shown in Fig. 11. This arrangement is applied to the rear end of the Pittler turrets, which are mounted on a horizontal axis. There are sixteen holes in the turret for tools, and a stop is provided for each hole. All the rods are held in the rim of a disk secured to the rear

end of the spindle, on the other end of which the tool disk or turret is secured. The turret slide *A* travels, bringing one stop-rod at a time against the fixed bed.

An arrangement of multiple stops, "selected" by a radial action, though not set in a circle, is used in the Pratt & Whitney turret lathes. Each stop-rod is held in an adjustable bracket *A*, Fig. 10, bolted to the front side of the bed, set-screws being used for clamping; three of these only are visible in the view. As the turret rotates, a cam *B*, cut on its base, operates a roller *C* mounted on a pivoted lever *D*, and thus brings the flat end of another lever *E*, which is set-

slotted bar *A* somewhere in front of the turret slide, and gearing it up to the turret to turn in unison with the latter, so that a new face of the bar will be presented for each turret face presented to the work. T-slots in the bar provide for the attachment of stop-blocks or nuts, any number of which may be used on one face. As the turret slide travels along, these nuts come against either a trip lever or a dead stop which lies in their path, and so throw out the feed, and gen erally also act as dead stops. In the illustration, the nuts which happen to be on the face nearest the turret are touched by the bar *B*, and, by forcing this down, operate a rod that

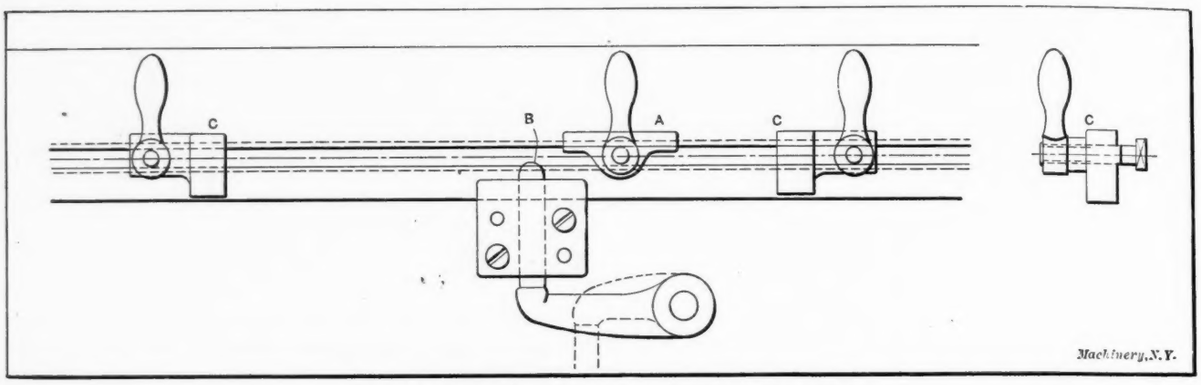

Fig. 15. Combined Trip and Dead Stops for Milling Machine Table

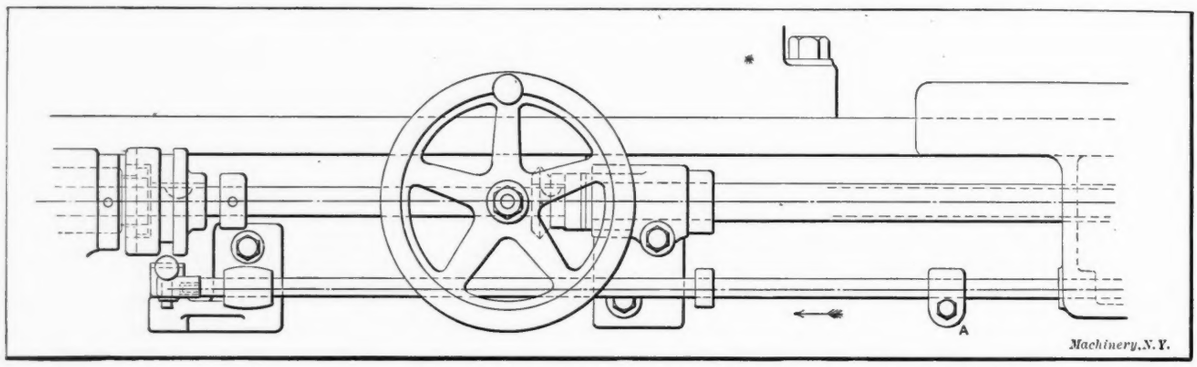

Fig. 16. Trip for Turret Lathe Cross-slide

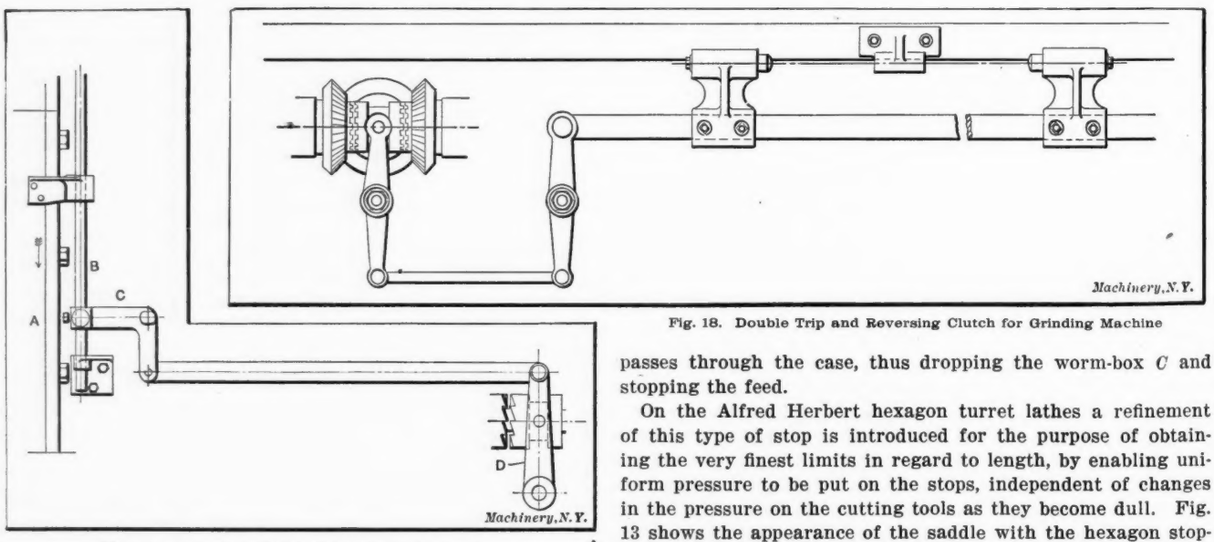

Fig. 17. Example of Single Trip without Reversal

Fig. 18. Double Trip and Reversing Clutch for Grinding Machine

cured to the shaft of *D*, into line with one or another of the stop-rods, corresponding to the position of the tool-holes in the turret. The lever *E* is backed up by a lug projecting from the turret slide (not shown), taking the thrust, and eliminating spring.

A type of rotating stop which has been extensively adopted by turret lathe manufacturers during recent years is illustrated in Fig. 14. The principle is that of fitting a rotating

passes through the case, thus dropping the worm-box *C* and stopping the feed.

On the Alfred Herbert hexagon turret lathes a refinement of this type of stop is introduced for the purpose of obtaining the very finest limits in regard to length, by enabling uniform pressure to be put on the stops, independent of changes in the pressure on the cutting tools as they become dull. Fig. 13 shows the appearance of the saddle with the hexagon stop-rod in front, and the pilot handle or spider. In front of the latter is a disk *A*, rotating with the shaft, and carrying three adjustable dogs (see the detailed view, Fig. 12) with index lines upon them. The saddle has a fixed sector with three lines corresponding with those on the dogs. After the feed has been tripped by the contact of one of the stops on the bar with the end of the vertical plunger seen in Fig. 13, the saddle can be moved a short distance by hand up to a dead stop. When the saddle is hard up against this stop, one of the dogs

on the disk is set to come opposite one of the three index lines on the sector. The dog thus forms an accurate means of measuring the pressure on the dead stop. If more than one length is required the two other dogs may be brought into use.

The combined trip and dead stop is found in other machines besides turret lathes. Fig. 15 represents the front of

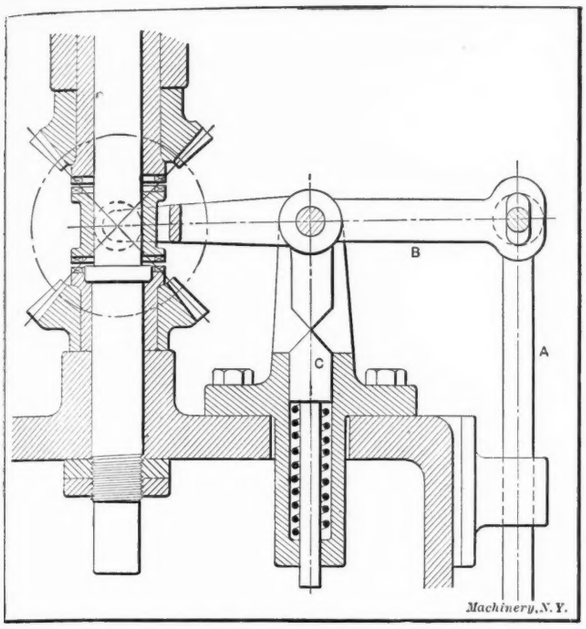

Fig. 19. Method of Locking Clutch by Spring Plunger

a milling machine table, with a trip dog *A* which presses down the plunger *B*, and through a pair of levers throws out the feed. The stops *C* are set to abut against the block which receives *B*, and thus act as dead stops, positively arrest-

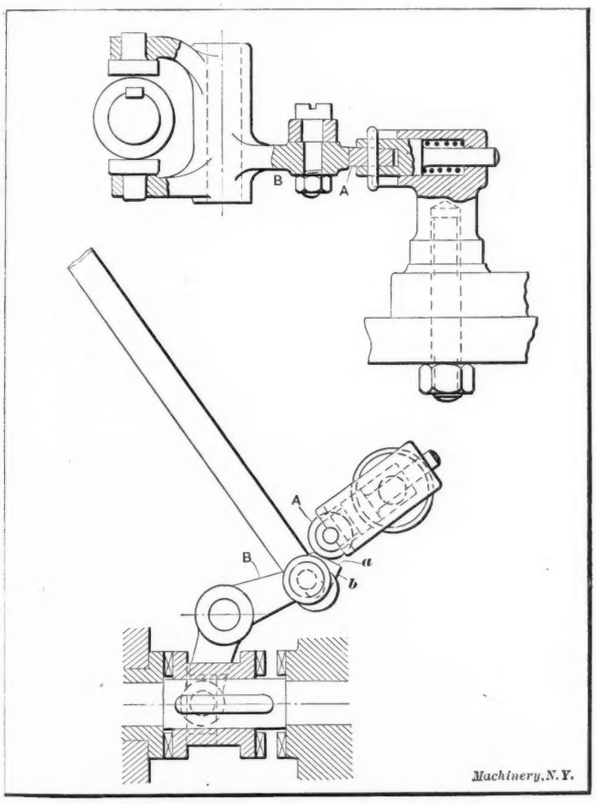

Fig. 20. Spring Plunger applied to Clutch-reversing Mechanism

ing the table, so that dead lengths can be milled. If the milling cutter simply has to clear over the ends of the work, the dead stops need not be set, but if the travel has to be stopped at definite positions, they are brought into employment.

When a feed has to be tripped, the actual medium by which it is thrown out depends on circumstances; it may be either through shifting belts, by sliding clutches—toothed or friction—or through a drop-worm. The difficulty with toothed clutches is that of insuring the re-engagement of the teeth. They are reliable enough, when hand-operated, but may fail when an attempt is made to render the mechanism self-acting, unless the clutches are actuated by springs or a lever. To render the action absolutely precise, an element must be included to cause both the release and the engagement to take place at an instant. A spring plunger is the device often adopted. A spring is compressed by the movement of the striking lever, which at the same time releases a trigger or catch, setting the spring free to push the clutch into engagement. This method is obviously capable of various applications. The springs may be actuated by a lever or by cams or by other means. A latch or latches lock the mechanism, rendering it impossible to throw any other movement in until they are released. This feature is worked out in various ways and is embodied in several gear-cutting machines to prevent interference between the indexing and cutting operations.

Two types of simple trips, operating clutches which must be re-engaged by hand, are shown in Figs. 16 and 17. The

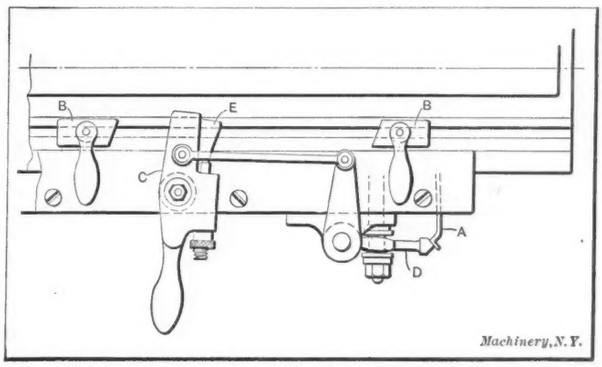

Fig. 21. Spring Locking Arrangement for the Shaper-reversing Mechanism

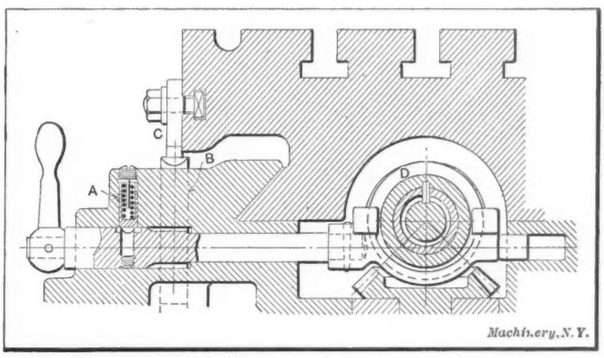

Fig. 22. Locking Mechanism for Clutch for Milling Machine Feed-screw

first is for a turret lathe cross-slide, the second for a gear-cutting machine. In Fig. 16 the saddle strikes the clamp-collar *A* on the stop-rod, moving the latter to the left, and actuating the lever which throws out the toothed clutch, stopping the feed to the saddle. In Fig. 17 the function is similar, in that the downward movement of the slide *A* is stopped; a bracket bolted to this embraces the rod *B* on the fixed part of the machine, and strikes the lever *C* which actuates, through a link, lever *D*, thus throwing out the clutch, and stopping the feed.

A double trip and reversing mechanism for a large grinding machine is shown in Fig. 18. In this arrangement the dog is bolted to the edge of the moving table, and strikes against adjustable dogs on the flat striking bar, which is connected by levers to the toothed clutch. In this design the table feeds and reverses so long as the driving mechanism is running. This brings us to the question of locking, that is retaining a clutch or other gear in mesh as long as it has to drive. Without some means of locking, there is nothing to prevent the clutch from disengaging under the effects of vibration. The simplest and most common method is to fit a spring plunger with a pointed end, or with a roller, which slips down along a beveled end on one of the levers, or into

recesses, there being many ways of accomplishing the desired result. Fig. 19 shows the principle applied to a toothed clutch set between miter gears, for reversing a grinding machine. When the stop-rod *A* is shifted endwise it moves the lever *B* over, and the left-hand end of *B* throws the clutch into mesh. Simultaneously the plunger *C* moves outward

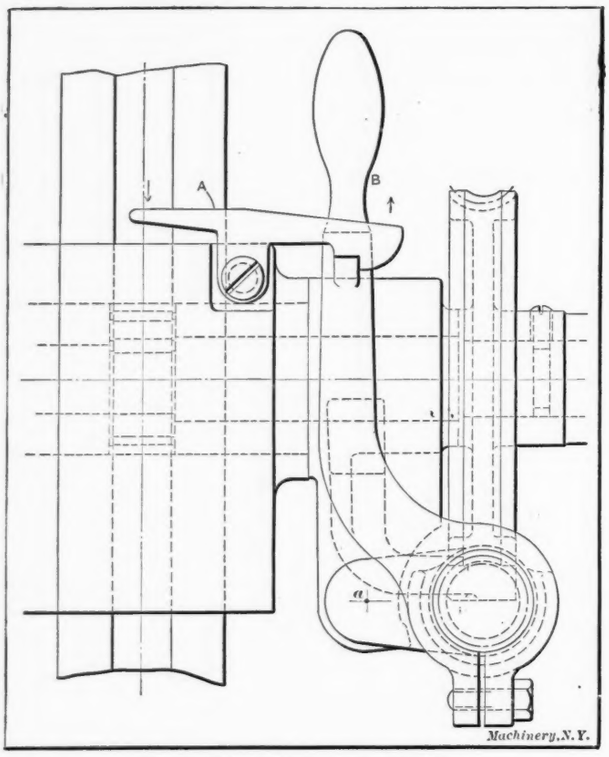

Fig. 23. Trigger Trip for Drop Worm-box

under the action of the coiled spring, and its beveled end locks with the beveled end of the short extension on *B*, thus forcing the clutch positively into full engagement, and holding it there until reversal again occurs. Another example of the spring plunger arrangement is illustrated in Fig. 20. This design is taken from the clutch-reversing mechanism of a special gear cutter. The locking is effected by a roller *A* mounted in a stup or plunger, and forced outward by a spiral spring contained in the holder. As the lever *B* is thrown over by the long lever pivoted to it, the roller is moved from the flat face *a* to the face *b*, thus retaining lever *B* in position.

Another method, see Fig. 21, utilizes the bent end of a flat spring *A* to lock the beveled end of a lever in its two positions. This example is taken from a shaping machine, in which the dogs *B*, bolted to the T-slot in the top of the ram, encounter the trip lever *C* and throw it over, thus actuating the two connecting levers which move the lever *D*, the latter sliding the rod which throws in the friction clutch inside the belt pulleys. *E* is a wedge, adjusted in either direction by the screw and knurled nut, by which fine adjustments in length of stroke are obtained while the machine is running.

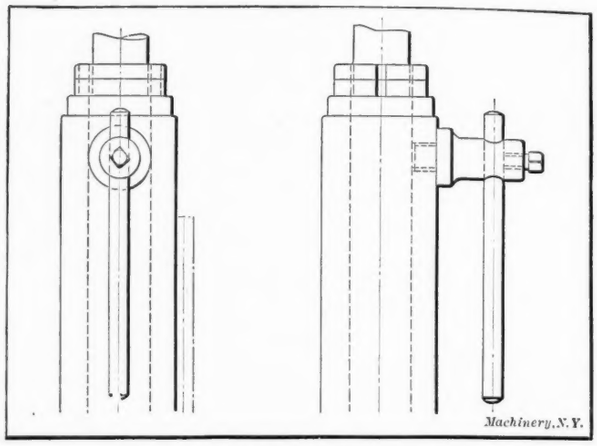

Fig. 24. Trip Rod Fitted to Drill Press Sleeve

In cases where a clutch is thrown over by the part rotation of a spindle, the latter may be utilized in connection with the locking as in Fig. 22, which shows a mechanism for a milling machine table. A plunger is situated at *A*, which catches in the stud inserted in the spindle below, and retains the latter in position. The part rotation of the spindle is effected through a plunger rack *B*, meshing with the teeth cut on the spindle, and forced downwards by the bevel-edged dog *C* on

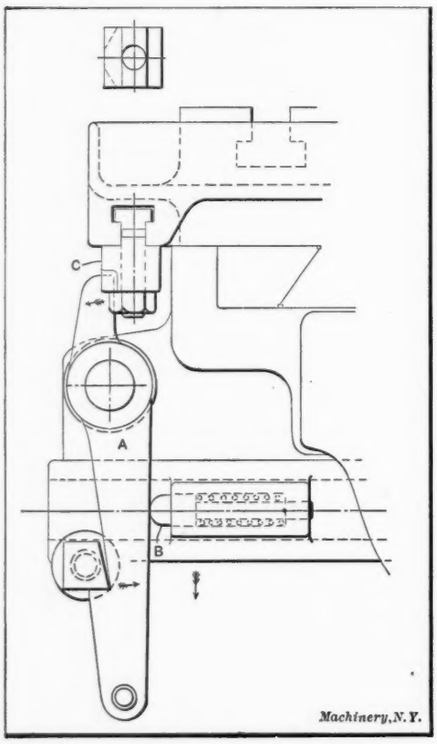

Fig. 25. Latch for Drop Worm for Milling Machine

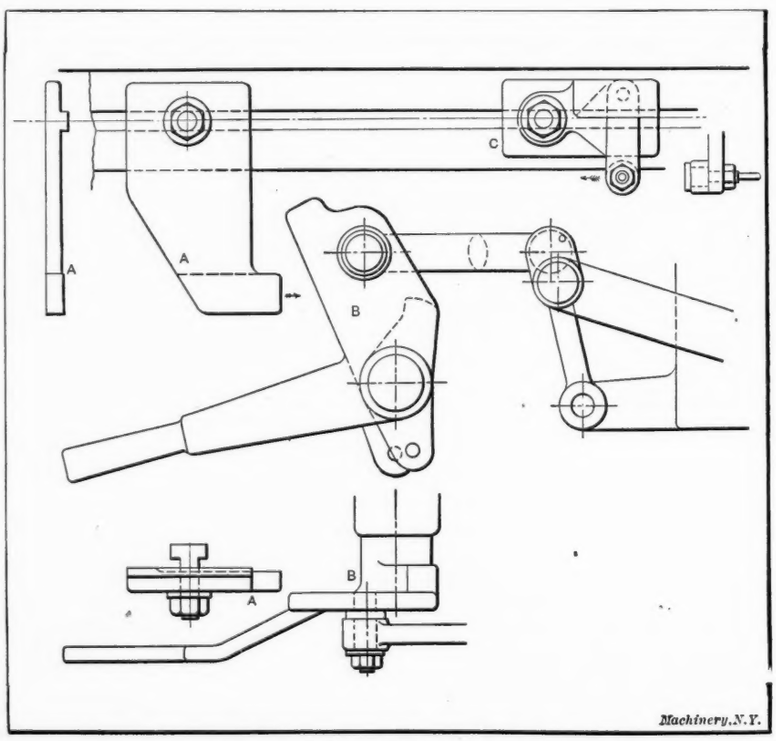

Fig. 26. Belt-shifting Mechanism for Planer

the edge of the table. *D* is the toothed clutch thrown into gear by the movement of the spindle, thus setting the table feed-screw into action.

Worm trips are very much in favor on account of their simplicity and their instantaneous effect. The box containing the worm is simply released and falls by the action of gravity, instantly disengaging the teeth from those of the wheel. Two examples of this mode of action will suffice. Fig. 23 is a trip applied to an upright drill, in which the end of a lever *A* is struck by the downcoming collar or rod on the spindle sleeve, raising the other end of the lever, which is formed as a trig-

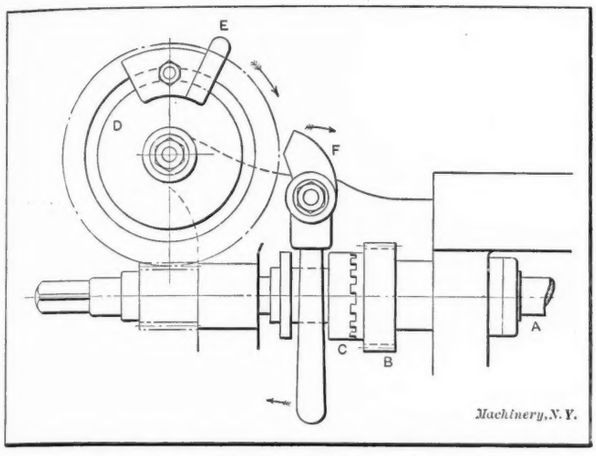

Fig. 27. Trip of the Disk Type used on a Boring Mill

ger, and releasing the handle *B*, which is clamped to the worm-box, pivoted at point *a*. The worm-box and handle turn on the axis passing through *a*, and thus the worm is allowed to fall away from its gear. The striking of the lever *A* is generally accomplished by an adjustable collar, clamped at any desired position on the spindle sleeve, or by a rod, as in Fig. 24, held in a stud projecting out from the sleeve.

Fig. 25 is a drop latch fitted to the table of a vertical milling machine, which drops the worm from engagement with the gear that turns the table screw. So long as the latch *A* remains in the position shown, maintained by the spring

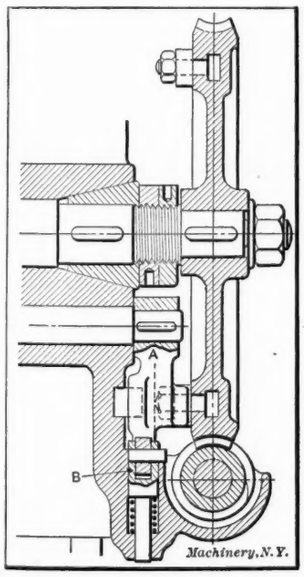

Fig. 29. Trip Actuated from Worm-wheel

plunger *B*, the shoulder cut in it retains the end of the worm-shaft bearing in place, but when dog *C* on the under side of the table comes against the short end of *A*, the latter is tilted, and the worm drops.

With regard to belt-shifting mechanisms, the difficulty of producing the necessary amount of belt travel with a small amount of stop lever movement is overcome by magnifying the effect of a cam plate and long belt levers. The operating tappet mechanism is comparatively simple, comprising in general a striking dog *A*, Fig. 26, which knocks over the lever *B*, connected by other levers with the belt-shifting mechanism. The return of the lever *B* is produced by the other dog or tappet *C*, the catch of which can be tipped up, out of the way.

The fitting of trip motions to disks is adopted in various ways, a stop-block being usually bolted to the disk so that at

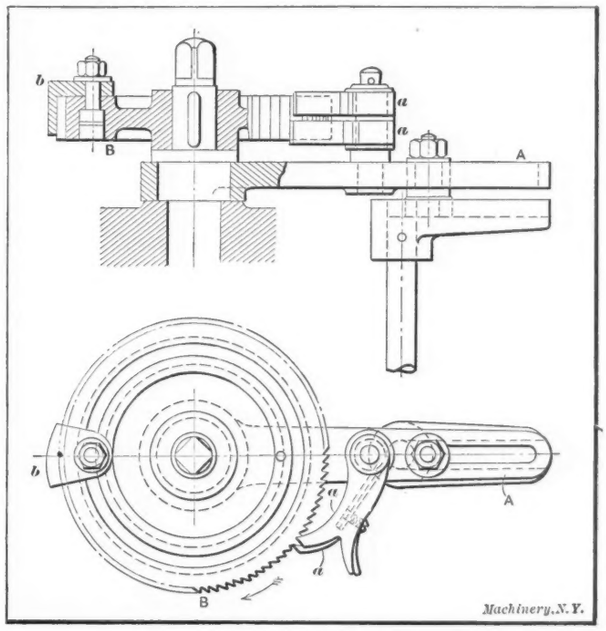

Fig. 28. Ratchet Feed Trip for Gear-cutter

a certain point in the revolution, the block actuates the trip gear and throws out a certain movement. Thus in Fig. 29, the worm-wheel has dogs bolted to a T-slot in its face, and these dogs strike a swinging lever *A*, thus imparting a partial rotation to the shaft on which it is keyed, and dropping, through a rack and pinion, a slide which carries a sector gear that has to be disengaged. The spring plunger and roller *B* keep the lever *A* in either of its two positions, the roller

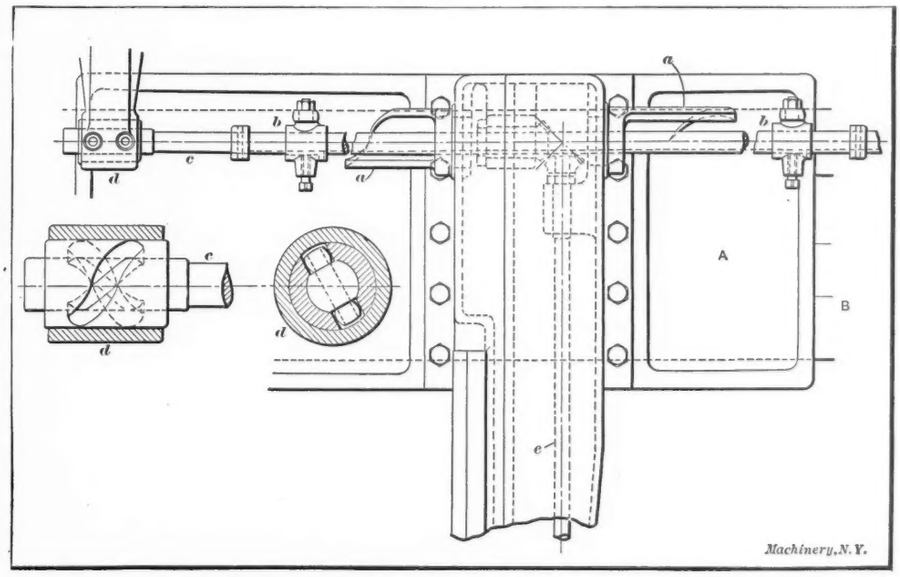

Fig. 30. Combined Reversing and Feeding Mechanism for Side Planer

pressing on one or the other of the two slopes of the beveled end. Another interesting application of the disk trip is illustrated in Fig. 27, which shows the end of a boring mill cross-rail. When the clutch *C* is in gear, the feed-screw *A* is turned by a gear *B*, operated from other spur gears not shown. A worm-wheel *D*, with a T-slot in its face for carrying a dog *E*, is driven by a worm on the extension of the screw *A*. When, therefore, the clutch is in mesh, the wheel *D* con-

tinues to rotate until *E* comes in contact with the beveled end of the trip lever *F*, and the latter is pushed over, disengaging the clutch, and stopping the rotation of *A*. Dog *E* is set at any required position on the circle to trip the feed at the desired position of the cross-slide on the rail. Another variation of the same idea is shown in Fig. 28, illustrating a feeding device for a gear-cutter. A slotted lever *A* is rocked to and fro, and by means of the pawls *a* gives intermittent turning movements to the ratchet wheel *B*. This continues until the dog *b* comes in the way of the pawls, which are then thrust out of engagement with *B*, thus stopping the feed.

In certain cases the feed is engaged automatically at the same time that the reversal occurs, as in planers: An interesting device, applied specially to the Richards' side planing machines made by Geo. Richards & Co., Ltd., Manchester, is used for giving the down feed to the tool-box that is situated at the end of the long arm. When the saddle *A*, Fig. 30, travels along the bed *B*, propelled by its screw turned by belt pulleys with open and crossed belts, a pair of horns *a*, bolted

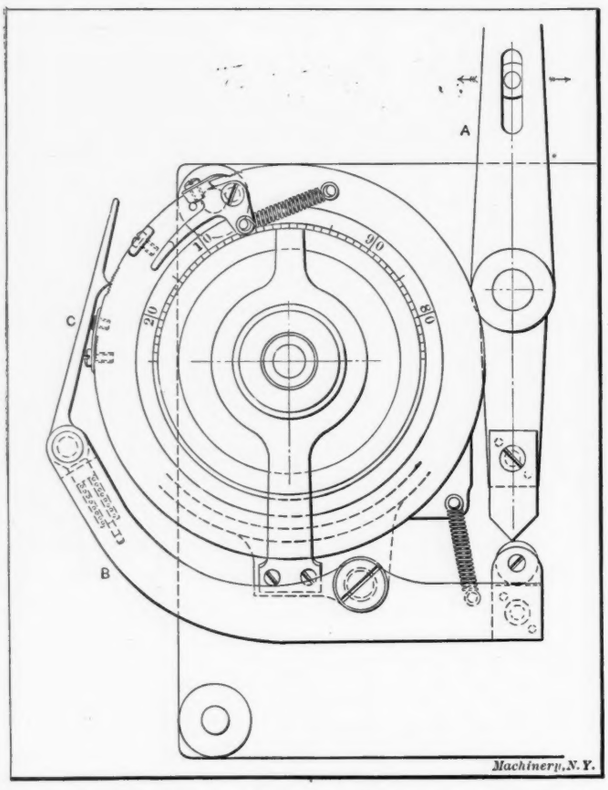

Fig. 31. Combined Reversing and Feeding Mechanism for Grinding Machine

to *A*, strike dogs *b*, mounted on a rod *c*, which by its longitudinal movement actuates the belt-shifting mechanism and produces the reversals, as in an ordinary planer. But the rod *c* is also given a twisting movement, in the following manner: Within the bearing *d* is a bushing, having cam grooves cut in its walls as shown in the enlarged detail, these grooves receiving rollers on the ends of a pin that passes through the rod *c*. When therefore *c* is slid endwise it must twist the rod, because the bushing cannot turn. Another rod *e*, through the medium of miter gears, imparts the down feed to the screw of the tool-box through a ratchet gear.

The combined reversal and feed is also applied to grinding machines, to feed the wheel a slight amount after each pass or stroke. One illustration of this class of mechanism as fitted to the Birch grinders is seen in Fig. 31. The rocking of the lever *A* in alternate directions when struck by the table dogs has the effect of rocking *B* up and down, and causing the spring-maintained pawl *C* to feed the disk, on the periphery of which fine ratchet teeth are cut. Hand adjustment is obtained by the small lever seen near the top. A somewhat more elaborate type of mechanism was shown in MACHINERY for May, 1909, in an article entitled "Machine Shop Practice—Cylindrical Grinding."

SPECIAL TOOL-ROOM APPLIANCES IN A RAILROAD SHOP

By RALPH E. FLANDERS*

The tool-room at the Juniata Shops of the Pennsylvania Railroad, at Altoona, Pa., is remarkable for the range in size and accuracy of the work it is called upon to perform. Not only do they make here the rough dies required for bull-dozer and other machine forging operations, but the workmen are prepared at a moment's notice to break off on such work and undertake the building of the fine instrument parts for a locomotive test plant or a precision dynamometer car. Besides this ability to do fine work, there is a large fund of native ingenuity lying around loose in the organization. The tools and devices herewith illustrated and described will give ample evidence of the truth of this assertion.

Micrometer for Odd-fluted Reamers, etc.

Fig. 1 shows a simple special micrometer. It is used for measuring the diameters of counterbores, reamers, etc., with odd numbers of flutes. It performs this awkward operation in a simple and easy manner. As may be seen, the instrument resembles a vernier caliper, having a blade provided with a split hub for clamping to the tail center of the grinding machine; the usual adjustable jaw and fine adjustment slides are provided. There are, however, no scale or vernier graduations. What would ordinarily be the jaw carries a micrometer spindle instead.

To illustrate the use of this instrument, suppose it is desired to grind a counterbore, like that shown, to a diameter of 2.396 inches. First a standard 2-inch plug gage is set on the centers of the grinder, and the slide or jaw carrying the the micrometer spindle is adjusted until the graduations on the spindle read to zero when the point of the measuring screw is brought down against the surface of the plug. The micrometer spindle is now screwed back out of the way, and the work is set in place on the centers. The counterbore is to be ground to a diameter 0.396 inch larger than that of the standard plug, or to a radius one-half that, or 0.198 inch, larger. It is therefore ground until, when measured by the micrometer in the way shown in the engraving, the graduations on the barrel of the micrometer read 0.198 inch, which shows that the counterbore has been reduced to the required diameter.

Grinding Reamers with Eccentric Relief

Figs. 2 and 3 show an eccentric reamer grinding device, which is in almost constant use, owing to the immense number of straight and (particularly) taper reamers used about a railroad shop. This device grinds the reamers eccentrically, so that they are provided with a better relief at the top of the blades than is given with the old-fashioned straight or concave grinding. The action consists in rocking the reamer about a center, so set as to give the proper contour to the blade being ground. This rocking takes place rapidly and continuously, while the table is moving the reamer back and forth past the wheel by the regular reversing feed mechanism.

The device is operated by a belt from the countershaft, running over the pulley which is mounted on a shaft connecting the two heads *C*. The mechanism is identical in each head. The shaft on which the pulley is mounted is connected by an adjustable cam movement with the sleeves *B* in which the work centers are mounted. This mechanism rocks the sleeves rapidly, and with them the work. The centers in each head may be adjusted in their sleeves to the proper degree of eccentricity and to the proper position. Provision is likewise made for indexing the reamer from one tooth to the other, as each is completed. As shown in Fig. 3, this consists of a gage *D*, provided with a tooth-rest against which each blade of the reamer is lined up in turn, while it is being adjusted for sharpening. This rest is swung out of the way before the rocking mechanism of the attachment is started in operation.

All the various adjustments provided facilitate the operation of the grinding to such an extent that the device is practically as rapid in operation as the old style arrangement giving flat or concave relief; and at the same time it gives

* Address: Springfield, Vt.

far superior results. The heads *C* can, of course, be set to any center distance, and the table of the machine can be set to any angle for taper reamers. All the other adjustable features of the standard grinding machine have also been retained.

The Thread Pitch Testing Machine

In Fig. 4 is shown what is in some respects the most interesting of the special tools which have been made and used at

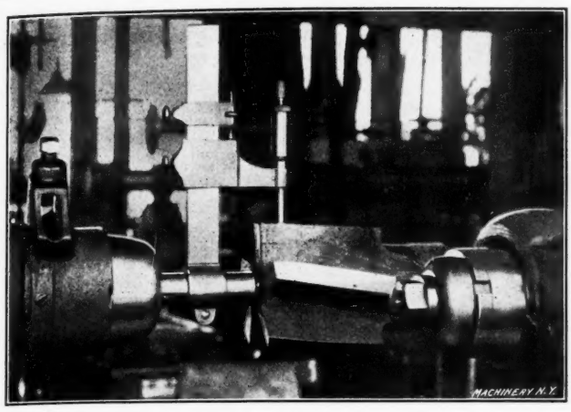

Fig. 1. Micrometer for Measuring Odd-fluted Counterbores, Reamers, etc.

this shop. This is a thread testing device, which finds steady and profitable employment in the measurement of taps, stay-bolts, lead-screws, etc. The device is mounted on a baseplate *E*, and is provided with head- and foot-stocks *F* in which centered work is mounted, and with V-supports *G* for uncentered work. These are shown in use in Fig. 6. The V-supports are provided with vertical adjustments for bringing the center

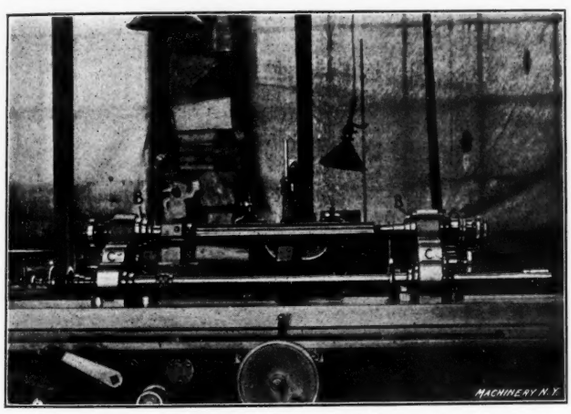

Fig. 2. Eccentric Grinding Device, for Straight and Taper Reamers

line of the work parallel with the base, and at the same height as the measuring points of the instrument.

The instrument or indicator itself is most plainly shown in the detail view in Fig. 5. It comprises a standard on which is pivoted a sensitive spring pointer *H*, and a stationary pointer *J*. The latter is mounted on a bar *K*, which may be minutely adjusted lengthwise by the adjusting screw *L*. The indications of pointer *H* are read on dial *M*, whose support may be adjusted in a circular dove-tailed slot about the center of the pivot of *H*, to bring the reading to zero whenever desired. This adjustment is effected by screw *N*, and is clamped by screw *O*. Spring stop-screws *P* limit the extreme movements of the needle.

The method of using this instrument will be readily understood from the engravings. One form of test which may be made with it is that of investigating the uniformity of the lead of a supposedly accurate screw. In Fig. 4, for instance, the points are adjusted to span any suitable number of threads, and the instrument is pushed up to the screw to be measured until the measuring points are firmly pressed into the threads. Scale *M*, see Fig. 5, is then adjusted until the pointer indicates zero. The instrument is then moved from one place to another, along the thread, and in all positions the pointer should evidently indicate zero, if the thread is uniform in pitch through its entire length. If it is not uniform, this will be shown in the variation from zero in one direction or the other of the pointer on the dial; and the amount of variation can be read, since the dial is graduated to thousandths of an inch.

Another use of this tool is in finding the amount by which threads are longer or shorter than the true pitch. In this kind of investigation the indicator is first set to zero, as previously described, on a model screw of known accuracy. The unknown screw to be tested is then put in place in the machine and measurements are taken at various points along its length. The readings given on the dial then show whether the pitch is long, short or irregular, and how much it is out in either case.

This instrument has the advantage of measuring on the sides of the thread at or near the pitch line. The indicating

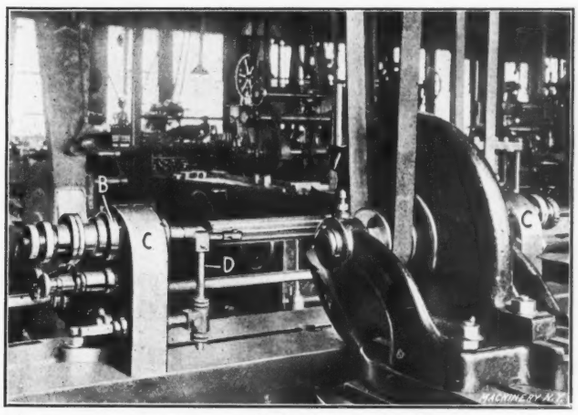

Fig. 3. Rear View of Reamer Grinding Attachment, showing Tooth Gage

points are given the shape of balls, and various sizes are provided to suit various pitches and shapes of threads. An extra set is shown at *Q* in Fig. 4. Various model screws for comparative measurements are also shown in this engraving at *R*, and bars of various lengths for carrying the fixed indicating point are shown at K_1 and K_2. The whole arrangement makes the instrument practically universal in application, since baseplates of any length may be used, or long lead-screws may be held on any plane surface, suitably supported with their center lines parallel with the base and at the right height for the instrument.

Results of a Campaign of Thread Testing

This apparatus made its debut in the work of testing the lead of stay-bolts and of stay-bolt taps. As every boilermaker knows, it is a matter of considerable difficulty to keep the pitches of the corresponding bolts and taps accurately to

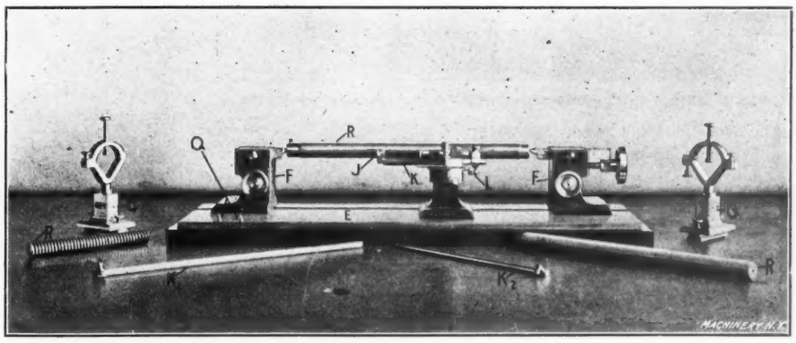

Fig. 4. Instrument for Testing the Accuracy of the Pitch of Screw Threads

standard. If they are not accurately to the standard pitch, the stay-bolt, when it is screwed into place, springs the fire-box sheets out or in, as the case may be. Thus some of the bolts are under initial compression, while their neighbors may be under initial tension, so the fire-box and side sheets in the

boiler itself are sprung out of true in every way, setting up dangerous internal strains which bring delay and danger in their train.

Two important reforms resulted from the investigations undertaken on these matters. One of these was the design of an automatic machine for cutting stay-bolts, in which the die was guided by an accurate lead-screw. This settled the stay-bolt trouble. The second reform made was the manufacture of stay-bolt taps in the tool-room of the Juniata shops, instead of buying them from commercial manufacturers. It was at that time found impossible to obtain commercial taps which came up to the limit of accuracy considered necessary for boiler work on the Pennsylvania Railroad. For a number of years, therefore, the tool-room has been making all the stay-bolt taps used, with satisfaction to all parties immediately concerned.

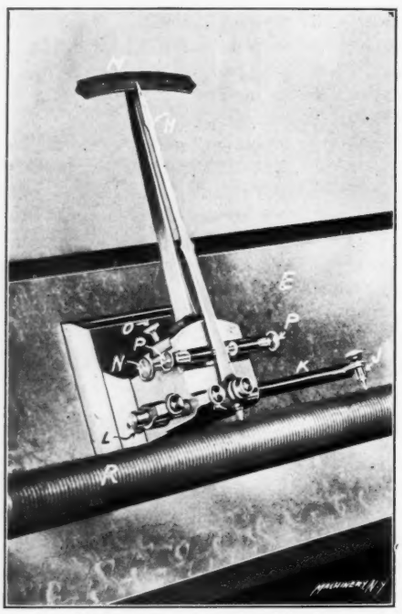

Fig. 5. Detail View of the Thread Testing Indicator

* * *

COMPARISONS BETWEEN ENGLISH AND AMERICAN LATHE DESIGN

In addressing the Sheffield (England) Society of Engineers on "Comparisons between English and American Lathe Design," Mr. G. W. Burley, of the Applied Science Department of the Sheffield University, stated that in almost every detail, lathes of English and American design differ. In regard to high-speed lathes, Americans are adopting gear-driven feed-rods, while English lathe designers are returning to the belt, their reason being that the belt acts as a safety valve and prevents breakage should anything occur to the tool causing it to refuse to cut. The main features of American lathes were stated to be handiness and facility of operation, while the main features of English lathes were strength and capacity.

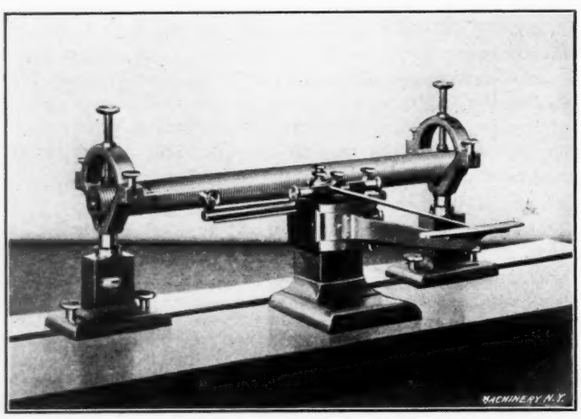

Fig. 6. Thread Testing Instrument with V-block Work-holders in Use

* * *

Investigations conducted in 1908 by Mr. A. Philip indicate that in order to obtain phosphor-bronze of a tensile strength of 38,000 pounds per square inch, with an elongation of not less than 20 per cent, it should consist of a mixture within the following limits: copper, 90 to 92 per cent; tin, 9.7 to 7.4 per cent; phosphorus, 0.3 to 0.6 per cent.

THE STATUS OF PROCESS INVENTIONS*

By E. D. SEWALL†

The laws of the United States provide for the grant of a patent to any one who has invented any new and useful art, machine, manufacture or composition of matter. An "art" within the meaning of the patent law is a way of accomplishing a result—a process, or a method.

The patent laws do not extend protection to all inventions. The Constitution authorized the enactment of such laws "to promote the progress of science and the useful arts." It is therefore clear that the subjects of invention for which patent protection may be had are limited to those that fall within the domain of science and the useful arts.

There are no doubts that new and useful machines, manufactures, and compositions of matter are subjects for patent protection, because inventions of such character clearly fall within the constitutional limitation. Machines and manufactured articles are concrete things cognizable both by the senses and the intellect. They are vendable commodities—products of the industrial arts. The doubts arise with respect to "art" or process inventions, which are abstract things, cognizable only by the intellect, although the results of such inventions may or may not be perceptible to the senses.

Judicial interpellation indicates that process inventions whose results can be apprehended only through the intellect are not patentable, while those that produce a change in the condition of matter that is perceptible to the senses may be patentable. Thus, a method of doing business, of training and educating animals, or of playing a game of cards is not patentable, while a way of making a chemical composition or a car wheel, developing power, or transmitting sounds may be patentable. The first three of the methods referred to are purely intellectual schemes producing no physical changes, while the last three effect perceptible changes in the condition of matter.

Thus, with respect to art or process inventions, arise the most fundamental doubts in the law of patents. And with respect to such inventions, even when clearly relating to the "useful arts" within the constitutional provision, the greatest uncertainty has prevailed throughout the history of patent law, both in this country and abroad. Courts, lawyers of long experience, and the Patent Office, have denied the protection of a patent to new and useful arts which were admittedly inventions. They have doubted the patentability of a process when apparatus was essential to its practice, or when no chemical reaction or "similar elemental" force took part in it.

Prejudice Against Process Patents

This prejudice against and this uncertainty with respect to processes, has resulted in injury to inventors as well as to the public. It has lost to inventors the full measure of protection to which their inventions entitled them, and has rendered so uncertain a large part of the property in inventions, especially the more fundamental ones, that the interested public hesitates to manufacture and use what seems to be unprotected by patent for fear of some unexpected construction by the courts.

The phrases "mechanical process" and "function of the machine" have been disastrous to many a valuable invention. It has been enough to say that a process is merely "manipulative," involving "no chemical or other elemental action," to deny its patentability. And the description and illustration of a machine adapted to carry out a wholly new and valuable process in an application for a patent for that process, have been sufficient excuse for refusing a patent for that process on the ground that it was the mere function of the machine illustrated and described. Also, patents have been refused for new manipulative processes of making old manufactures while, absurdly enough, claims have been allowed for the old manufactures defined by the way in which they were made. And, with equal absurdity, where claims for new processes

* For other articles on patents, previously published in MACHINERY, see: "Forfeiture of Patent Rights," December, 1908; "Unlawful Uses of Patented Machines," October, 1908; "Patents and Inventors," August, 1908; "Patents and Inventors," June, 1908; "On the State of the Patent Office," March, 1908; "Patentability of Inventions," November, 1906; etc.

† Address: 1819 F St., Washington, D. C.

have been refused on the ground that they were the mere function of the machines set forth for practicing them, claims for the machines have been allowed in the bald terms of the several means for carrying out the successive steps of the denied process.

Assume it to have been generally perceived desirable to construct a car wheel with (1) a hard steel rim, and with (2) a soft steel hub and web, but that it was not known how it could be made and that an inventor discovers a way of making such a wheel. He applies for a patent for "a car wheel having a hard steel rim and a soft steel hub and web integral therewith," and also for the method of making it which consists in: (1) Forming a rim portion having a circumferential groove in its inner periphery, (2) separately forming a hub and web portion in one piece of less diameter than the internal diameter of the rim, (3) centering the hub and web within the rim, and then (4) enlarging the diameter of the web by applying forging pressure thereto to thin and expand it into contact with the surface of the rim within the groove and (5) weld uniting the web and rim.

The claim for the article meets with rejection because it defines only a conception of a thing recognized in the art as desirable—a mere perception of a want, an obvious article, the problem of making which had not hitherto been solved. The process claim meets with rejection because for mechanical operations involving "no chemical or elemental action." But, in recognition that the applicant has accomplished something new, he is allowed a claim as follows:

A car wheel having (1) a hard steel rim with a grooved inner periphery, (2) a hub and web of soft steel which has been made of less diameter than the inner diameter of the rim and has been expanded into contact with the grooved portion of the rim by forging pressure and welded thereto.

It is quite obvious that this is a case of whipping the devil around the stump. The wheel continues to be merely a car wheel having a soft steel hub and web, and a hard steel rim, a patent for which was refused. The groove in the inner periphery of the rim has disappeared in the finished wheel and the web diameter is no longer less than that of the rim. The real problem before the inventor was how to make such a wheel, and the invention, if there was any, lay in the solution of that problem, *i. e.*, in the process.

Assume, again, that one who has been making large railroad spikes in a spike machine finds that he has to heat the bar repeatedly, because of the slow operation due to the heavy duty of the machine, thus consuming a lot of time and deteriorating the quality of the metal. He observes that the metal can be shaped by rolling much more rapidly than by forging. He therefore conceives of passing the heated bar rapidly through a pair of die rolls so formed as to rough shape the bar into a string of connected spike blanks, and then immediately feeding the bar to a spike machine, which may be geared to high speed because of the light work left to be done in finishing and cutting off the blanks. Thus he finds that he can forge an entire bar into spikes at one heat. He therefore makes application for a patent for:

The process of making spikes consisting in (1) heating a bar, (2) die rolling it into a string of connected partly-formed spikes, (3) cutting off and finishing the partly-formed spikes by forging.

The specification discloses a furnace, a stand of die rolls and a spike machine arranged in tandem relation so that the heated bar may be withdrawn from the furnace and fed between the rolls and into the spike machine in a straight path. The process claim is met with a rejection on the ground that the alleged process is merely the function of the machines shown. The applicant therefore claims:

The combination of a furnace, a set of die rolls and a spike machine

and the claim is allowed. Here it seems obvious that the real invention lay in the conception of the way of making spikes. Hot metal cannot be worked with the fingers. The furnace, the die rolls, and the spike machine were all well known instruments for working metal, and any mechanic would know well what instruments to make use of upon the mere directions of the inventor *how* to make the spikes, to wit: to heat the bar, die roll it, and then finish by forging the blanks. The allowance of the combination claim in this case is clearly another example of whipping the devil around the stump.

To the simple-minded it looks as if in each of the assumed examples the inventor had not received a patent for his actual invention, and could only be protected in the practice of it by the favorable construction of the court in case the terms of the specification were such that it could be so construed. And the chances are that having canceled the claims to his actual invention the patentee will not be allowed the same claim by construction, and that the thing actually claimed will be held unpatentable.

No Sound Reason for the Prejudice

It is impossible to draw from any person holding this prejudice against process inventions a sound reason for his attitude. The prevalence of it can hardly be explained except on the hypothesis of a blind inheritance of belief in erroneous premises adopted early in the history of the English law, strengthened in the minds of the case lawyers by dicta in certain decisions of our courts. That is to say, the prejudices against mechanical or manipulative processes have about the same kind of vague foundations as popular superstitions.

Our patent laws, although deriving their authority from the Constitution, yet derive their principles from the English law. In ancient times the monarch of England had a prerogative to grant monopoly patents. "The king," said Sir H. Finch, "hath a prerogative in all things that are not injurious to the subject; for in them, it must be remembered, that the king's prerogative stretcheth not to the doing of any wrong." This prerogative was in certain cases wisely exercised for the purpose of bringing into England and teaching to English subjects arts and trades of which the English people were ignorant. In the time of Elizabeth and James I especially this prerogative was stretched to the doing of wrong by monopoly grants giving control of industries and commodities already in possession of the people. For this reason Parliament enacted the famous statute of monopolies (21 Jac. 1, c, 3) declaring that all monopolies, grants, and letters patent

"heretofore made or granted, or hereafter to be made or granted.....are and shall be utterly void..... Provided also, and be it declared and enacted, that any declaration before-mentioned shall not extend to any letters patent or grants of privileges for the term of fourteen years, or under, hereafter to be made, of the sole working or making of any new manufacture within this realm, to the true and first inventor and inventors of such manufacture....."

The statute of monopolies also excepted certain named existing grants such as the so-called smalt patents, which were for processes of making a certain blue dye and the product thereof, and Dudley's patent for a process of extracting iron from its ores by the use of sea coal.

English Court's Opinion on Watt's Alleged Process

In 1795 Watt's patent for a "method of lessening the consumption of steam and fuel in fire engines" came before the Court of Common Pleas. The specification set forth among other things, "My method of lessening the consumption of steam and consequently fuel, in fire engines, consists of the following principles: 1. That vessel in which the powers of steam are to be employed, to work the engine which is called the cylinder in common fire engines, and which I call the steam vessel, must, during the whole time the engine is at work, be kept as hot as the steam that enters it; first, by enclosing it in a core of wood, or any other materials that transmit heat slowly; secondly, by surrounding it with steam, or heated bodies; and thirdly, by suffering neither water nor any other substance colder than steam to enter or touch it during that time. 2. In engines that are to be worked wholly or partially by condensation of steam, the steam is to be condensed in vessels distinct from the steam vessels or cylinders, although occasionally communicating with them; these vessels I call condensers, and while the engines are working, these condensers ought at least to be kept as cold as the air in the neighborhood of the engines, by application of water or other cold bodies." It is not necessary to quote further.

Watt's invention was the greatest of that time. The steam

engine was then known and in practical use, but was inefficient. Newcomen's engine and that of the Marquis of Worcester had no provision for keeping the cylinder hot and the steam which had done its work on the piston was condensed in the cylinder by injecting cold water. The cylinder was always kept cold, therefore, and the steam rapidly condensed as soon as it was admitted to the cylinder.

Watt's primary conception of ways was that the cylinder should be kept as hot as the steam so as to prevent the loss of heat and power, and his secondary conception of ways was to withdraw it alive from the cylinder and either condense it separately or allow it to exhaust and go to waste. As means to this way of keeping the cylinder hot, he covered it with a non-conductor of heat and also provided a steam jacket for it into which he conducted live steam; and as means to his way of taking care of the exhaust, he led it into a separate condensing vessel.

Heat and methods of generating it were known at that time. The cylinder of Newcomen's engine could be kept hot by building a fire under it, thus putting into practice fully Watt's primary conception of economizing steam without the use of any new means. Vessels and means to keep them cool, as well as valves and pipes for conducting fluids, were also well known at that time. So that Watt's secondary conception of ways of avoiding condensation in the cylinder could be carried out by known means.

At the trial it was persistently insisted on behalf of the patentee that the invention was a process and that he was entitled to cover under the patent any means by which the cylinder could be kept as hot as the steam and the steam condensed outside thereof. The defense urged that such contention could not be sustained, as to do so would be to sustain a patent for an abstract principle.

On the question of construction the court divided three to one, three of the judges holding the patent to be for an improvement in the construction of steam engines, while the chief justice alone held that the patent was for a process.

The majority of the judges held that the word "manufacture" in the Statute of Monopolies meant a means—a "vendible commodity"—although admitting that the term "manufactures" was commonly used to designate both the commodities made and the practice of making them. The argument seemed to take form in their minds something like this: (1) The word monopoly by derivation means an exclusive right to sell; a patent is a monopoly; therefore a patent is an exclusive right to sell. (2) Only commodities can be sold; a process is not a commodity but a principle—a mere abstract idea—therefore a process cannot be sold. (3) Conclusion—A patent can only be for a vendible commodity, and Watt's contention that his patent is for a method cannot be sustained since only vendible commodities are patentable. It must therefore be for a mechanical construction and not for a method.

Chief Justice Eyre's Opinion

On the other hand, the Chief Justice in his minority opinion wrote these wise words:

"Undoubtedly, there can be no patent for a mere principle; but for a principle so far embodied and connected with corporeal substances as to be in a condition to act and to produce effects in any art, trade, mystery or manual occupation, I think there may be a patent. Now this is, in my judgment, the thing for which the patent stated in the case was granted, and this is what the specification describes, though it miscalls it a principle. It is not that the patentee has conceived an abstract notion that the consumption of steam in fire engines may be lessened, but he has discovered a practical manner of doing it, and for that practical manner of doing it he has taken his patent.

"The substance of the invention is the discovery that the condensing of the steam out of the cylinder and protecting the cylinder from the external air and keeping it hot to the degree of steam heat will lessen the consumption of steam. This is no abstract principle; it is in its very statement clothed with practical application: It points out what is to be done in order to lessen the consumption of steam. Now the specification of such a discovery seems to consist in nothing more than saying to the constructors of fire engines, 'For the future condense your steam out of the body of the cylinder instead of condensing it within it, put something round the cylinder to protect it from the external air and to preserve the heat within it.'..... Any particular means of doing this, one should think, would hardly need to be pointed out, for it can scarcely be supposed that a workman, capable of constructing a fire engine, would not be capable of making such additions to it as should be necessary to enable him to execute that which the specification requires him to do.

"Some machinery, it is true, must be employed, but the machinery is not of the essence of the invention, but incidental to it."

The Chief Justice also pointed out that the language of the statute of monopolies defined a monopoly to be "the privilege of the sole buying, selling, making, working, or using anything within this realm," and that the statute excepts from condemnation privileges of "working or making of any new manufacture," which seemed clearly not necessarily to limit a patent monopoly to a vendible commodity.

This language of the statute received very little attention from the majority. They appear not to have considered that the royal prerogative was earliest exercised for the purpose of introducing new *trades* and "mysteries" into agricultural England, nor that the statute expressly excepted certain process patents such as those mentioned above.

Within the fifty years following the case of Boulton & Watt vs. Bull, the English courts passed many dicta, generally unfavorable to process patents. In Crane vs. Price, decided in 1842, it was finally definitely decided that a valid patent may be had for a process, without deciding that merely manipulative or mechanical processes were patentable. Even later, English law writers are found strenuously maintaining that processes, saving only chemical ones, are not patentable inventions.

No more accurate notion of the fundamental principles of the law governing the grant of patents for process inventions has been expressed than that of Chief Justice Eyre in the Watt case.

Opinion in the United States on Processes

The original United States patent act of 1790 defined the subjects of patentable inventions to be, "Any useful art, manufacture, engine, machine or device." This language is probably Jefferson's. He was thoroughly familiar with the history of monopolies and doubtless used the word "art" advisedly as the scholarly word to designate new trades, "mysteries" and industrial processes. It has persisted in successive statutes until to-day, and the courts have never had any hesitation in declaring that it means an industrial process, although they have had hesitation in declaring that all industrial processes are to be included under it.

In 1843 in the case of McClurg vs. Kingsland, the United States Supreme Court held valid a patent for "a mode of casting chilled rollers and other metallic cylinders and cones," which consisted in injecting molten metal into a mold tangentially, thereby imparting a rotary motion to it, which had the effect of concentrating the dross at the center. In 1871 in Mowry vs. Whitney, the same court sustained a patent for a process of making cast-iron car wheels which consisted in casting a wheel in a mold, removing it from the mold as soon as it had cooled sufficiently to hold its form, then subjecting it to heat to raise its temperature uniformly to a point a little below that at which it fuses, and then slowly cooling it, thus carefully annealing it in all parts. In 1876, in Cochrane vs. Deener, a process of bolting flour by passing it successively through bolting cloths of successively finer mesh and applying air currents close to the surface of the cloths to remove the finer impurities, was sustained. In 1880, in Tilghman vs. Proctor, a process patent for the manufacture of fat acids and glycerine from fats by the action of water at high temperature and pressure was sustained. Many patents have been sustained where the claim was for a chemical reaction to produce a new substance or an old substance in a new way. In 1888, Bell's patent was sustained for "the method of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds." In 1898,

the Supreme Court, in Westinghouse vs. Boyden said "it may still be regarded as an open question whether the patentability of processes extends beyond this class of inventions" (meaning by "this class of inventions" those "which involve chemical or similar elemental action." In 1909, the Golding patent for a method of making expanded metal lathing by slitting, stretching and bending the slitted portions into diamond-shaped meshes, was sustained by the Supreme Court after the same patent had been held invalid by the Court of Appeals of one circuit on the ground that it was for a mechanical method—the mere function of the machine used—and had been sustained by the Court of Appeals of another circuit. In this case the Supreme Court cited with apparent approval the decision of the Circuit Court in Paper Bag Co. vs. Paper Bag Co., sustaining a patent for a process of making paper bags by folding the paper in a new way, the process having been practiced commercially by an automatic machine.

In 1853 the Supreme Court held invalid the claim of Morse for making intelligible signs at a distance by the use of the galvanic current, on the ground that it was a claim for a principle, and covered all possible ways of attaining the result arrived at. Since then it has invalidated many process patents as lacking invention. In 1895, it rendered a decision in the case of Risdon vs. Medart that has done more than any other ruling to unsettle confidence in process patents. That decision contained dicta from which it was widely inferred that only such processes as involved "chemical or similar elemental action" were of a patentable character. The actual point of the decision seems to have been based on the assumption that the process was the mere "function of a machine," although several machines were in fact used in making the pulley, which was the product that the process aimed to produce. Following this decision it seemed to be sufficient that a process was not of a chemical nature to deny its patentability. What the "similar elemental action" may be, has never been judicially defined.

Supreme Court Never Invalidated Clear Process Inventions

From the above hasty glance at a few decisions of the Supreme Court it may be deduced that neither a principle of nature, a desirable result, nor all ways of attaining a desirable result or applying a principle of nature, nor the function of a machine, are patentable subjects in their opinion. Specified ways of applying principles to secure a result, if they involve "chemical or similar elemental action," are subjects for process patents. The patentability of chemical processes has not been questioned. In one case, sustained, "similar elemental action" was centrifugal force applied to casting molten metal; in another it was the effect of heat applied so as to overcome the strains due to unequal radiation of hot metal when rapidly cooled; in another it was the application of air currents to flour in a certain way, as it was passed through bolting cloths; in another the application of electrical undulations to set up sound undulations in air; in another the mere tendency of paper to retain its folded form when folded, and in another the ductility and malleability of metal.

It is believed the United States Supreme Court has never reached a conclusion on the validity of a process patent that is at variance with the fundamental principles of lawful monopolies. They have never denied patentability to any process relating to the useful arts that involved invention, although there have been dicta from which misleading inferences can be drawn. It is difficult to reconcile a belief that manipulative or mere mechanical processes are not the subjects of a patent, in the opinion of the Supreme Court, in view of the decisions sustaining a process of bolting flour by the aid of bolting cloths and air currents, of folding paper in making paper bags, in slitting, bending and stretching metal in making metal lathing; or, in view of the same decisions, that the Supreme Court holds a process patent to be invalid where mechanism is absolutely necessary to practice it.

The Philosophy of Process Inventions

Three classes of inventions corresponding exactly with the intellectual laws of invention have always been expressly recognized in the United States statutes. These three classes are (1) the product or thing produced—represented by the words "manufacture" and "composition of matter," (2) the way or method of producing the product, or of accomplishing an industrial effect (when the product of the process is not a concrete thing, as a form of energy), represented by the word "art," (3) the instrument used to aid in practicing the "art," represented by the word "machine."

The order of inventive conception is (1) the product, (2) the process of making the product, (3) the machine for carrying out the process. In answer to the question "What shall I make?" the inventor conceives the product; to the question "How shall I make it?" he conceives the process; to the question "By what means shall I practice the process?" he conceives the machine. He must have a clear notion of a product before he can devise a process of making it and must perceive clearly the process before he can build a machine to practice that process. Patents rank in value in the same order. The patent for a manufacture gives the broadest possible protection, since subject to it are all possible processes of making it. The next broadest protection is afforded by the process patent since subject to it are all possible machines whose *modus operandi* is the process. The protection afforded by the apparatus or machine is the most limited of all. Of course a machine or apparatus may be the product desired, and the process of making that machine will then be inferior in patent value to the machine. Or the ultimate result may be an effect, not resulting in a manufacture, produced by a process carried out by the aid of a product which in turn becomes an instrument inferior in value to the process. But always, in the relation of value and rank, the process is higher than the instrument used in practicing it, and the product is higher than the process by which it was made.

Higher still than any of the three kinds of inventions—product, process, and apparatus—stand effect, result, principle, which are not inventions. In accordance with natural law and with the fundamental principles governing monopolies, principle, result, effect, cannot be monopolized. They are the property of all equally, and become known by perception, not by invention. There can be no lawful claim for an effect or principle. A claim in a patent or application for patent for an invention in any one of the three statutory classes conclusively concedes pre-knowledge of that which stands higher in rank. A claim for a product concedes pre-knowledge of the mode of using it and of the effect or results designed to be produced by its use; a claim for a process conclusively concedes pre-knowledge of the principles utilized in the process, of the product made by that process; and of all instruments the use of which is made a part of the process; a claim for an apparatus concedes previous knowledge of the process it is designed to practice.

The principles just stated are fundamental and essential to be applied in testing any alleged invention. It must also be remembered that all invention lies in the mental conception. For obvious reasons the invention is not a patentable one until it has been made potentially available to the public. But in testing any claim for the presence or absence of invention, the inventive conception must be resorted to and the rank of that conception determined.

Suppose one desired to make a hole in a metal plate. The production of the hole is the effect, not patentable. One way to attain this effect is to remove the metal by cutting it away in detail; another is by displacing the metal by forcing a punch into it; another by burning it in the presence of pure oxygen. One person might have a patent for one method, and another person a patent for another method of attaining this effect. Obviously the patent for displacing by the punch would not conflict in any way with that for oxidizing nor with that for cutting the metal away in chips.

Assume that the method of chipping away the metal is adopted. As metal cannot be worked without instruments an instrument for cutting a hole by chipping away the metal has to be devised. The twist drill is conceived, which is one of several instruments that will carry out the method of cutting the hole. A method of making this drill is now sought. One conceives of making it by twisting a properly formed straight blank, another by forging spiral grooves in a round blank, another by removing metal to form spiral grooves. None of the processes conflicts with the others or derives any-

thing from the others, but all derive something from the drill, and would infringe the drill patent. A machine is then sought that will carry out the desired method, say of removing material to form the grooves. A milling machine is designed. This should not infringe a patent for another machine which removes the metal by planing, but both would be subject to the process patent. And so process, product, and apparatus may proceed indefinitely. The metal plate with the hole in it may be a product, and also an instrument in carrying out another process; and the machine for making the drill may again stand in the relation of product to some other process.

No valid product patent can be so broad in scope as to prevent the possible allowance of other non-infringing product patents designed to secure the same effect. No valid process patent can be so broad as to hold as an infringement every other possible process patent for producing the same product. No valid machine patent can be of such scope as to close the field to other machines for carrying out the same process. By "possible" is here meant theoretically possible, as it may occur, as in the telephone invention, that the method discovered and applied is the only one. This is a fundamental truth of patent law, notwithstanding that the existing mass of patents fails to support it.

Process inventions are in general the most fundamental ones. They *are* the "useful arts." The most valuable manufactures have been known and used for years, and as ways of manufacturing essentially old products are the prime problems of manufacturing industries, it is most important to have process inventions protected.

A process is a way of attaining a result; and any process that is new, useful, and based on an inventive conception, is patentable under the law, if it is applied to "science and the useful arts." It matters not whether or not it includes "chemical" reaction or "similar elemental action," or is carried out by an automatic machine. The only conditions precedent imposed by the law are that it shall be new, useful, and an invention; and those conditions apply equally to all classes of invention.

The much discussed and much applied phrases "function of a machine," "mere mechanical process," should be dropped from consideration in determining the patentability of a process. They have no bearing on the question of invention involved in them. Process inventions should be approached in the same way as machine or article inventions.

In settling whether a defined process is patentable it must, of course, be determined that it is within the field of permissible monopolies, and if it is, then it must be ascertained, (1) if it is new, (2) if it is useful, (3) if it is an invention—nothing else. The question of utility presents little difficulty and that of novelty, none, except research into the existing art. The serious question is that of invention. In settling this, most of the negative rules applicable to machine inventions are applicable to processes, and there is no more mystery connected with the treatment of process than with the treatment of machine inventions. If the process alleged is an "aggregation" of separate processes, if it involves over an old process the mere substitution of an equivalent step, it is not patentable.

The word "mystery" was frequently applied to processes in the early days of patent monopolies. It was used in the decision of Boulton & Watt vs. Bull, above, and is a word that aptly indicates the essential quality of a patentable process. To be patentable a process must be mysterious to one who has not been informed. No process that is not mysterious, that does not include hidden steps, no process that is apparent when the result of it, or the principle involved in its practice, is considered, is patentable. The process of making a car wheel that consists in forming a wheel body of paper, and applying a steel tire thereto, is the obvious way of making the desired product, which is a paper wheel having a steel tire. The conception of the wheel came first. There was no room for further invention in the process. Merely practicing manufacturing steps that are apparent in the article made is not invention,—it is mere following copy. Furthermore, a patent for such a process covers by its terms all possible ways of making the defined article and violates an axiom of the law of monopolies.

Chemical processes have been uniformly admitted patentable. What are the "similar elemental actions" that render process inventions patentable? Can any one conceive of any acts performed on matter, gaseous, liquid, or solid, that do not take advantage of some elemental law of nature? One hammers iron into a nail, taking advantage of the laws of cohesion and malleability. One sifts ashes aided by the law of gravity, one folds paper, taking advantage of the property of flexibility. But whether elemental action is involved or not is wholly immaterial—such action probably always is involved—the sole thing to be considered is whether there is a "mystery" which this process has unraveled.

Every machine and every instrument operates to practice some process in whole or in part. The fact that that process is ancient and common makes it none the less a process. The process of smoothing wood by planing, or shaping iron by hammering, is still a process under the patent laws, although an ancient one. A process that is carried out by an automatic machine may be no less an invention than one carried out by hand or by chemical reagents.

A pair of revoluble rolls may manufacture sheet iron, if hot iron billets be passed between them, make breakfast food of corn or wheat, squeeze water out of wet clothing, flatten bent plates, calender paper, roll plate glass, etc. The function of these rolls is not to make sheet iron, crack wheat, wring clothes, or calender paper. It would hardly be sensible to reject a process of preparing grain for food by passing it between metal rolls, on the ground that the process is the function of the machine, for it is no more the function of the rolls to crush wheat than to make sheet iron or wring clothes. In approaching a question of this sort, instead of concluding at once that the process is the mere function of the machine, it should be considered in accordance with the fundamental principles. First, the result is disintegrated wheat in flaky form, conclusively old as a conception. The process of producing it by applying pressure sufficient to break down its resistance and flatten the grain, is disclaimed and conceded to the public. The rolls as a piece of mechanism are disclaimed. Their capability of applying pressure must be conceded as known. Was there then any invention in using a known pressure applying instrument, for carrying out a presumptively known process of flaking wheat by applying pressure?

Such a question is always one of invention. Some things cannot be done by hand. Gases cannot be confined without instrumentalities, and metals cannot be shaped by the fingers. Instruments are usually necessary to the practice of processes. A claim for a process practiced by a particular instrument as a rule does not define the real invention; but it is conceivable that the use of a particular instrumentality for practicing a process may be of the essence of the invention, or that a new process may be devised for operating an old machine. Denial of validity of process inventions by allegations that they are the mere functions of a machine would better give place to treatment by considering the novelty and utility in the abstract process or series of steps as a mental conception divested from any instrumentalities, and then, presuming the abstract process to be disclaimed, considering whether there was any invention in selecting the stated instruments to aid in practicing it.

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"Scissors, Five Cents" in a store show window called our attention to a collection of chilled cast-iron contrivances that by courtesy may be called scissors—but only by courtesy. Cheapness is a relative term. Compared with the price of really good scissors, the price five cents, is cheap, but when the quality is considered, they are dear at any price. One who values his time and material at anything could hardly afford to use such tools. The competition that leads to the production of goods so cheap and poor as these is destructive and dangerous.

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Emery wheels are beginning to be used in Sheffield, England, for grinding cutlery. Up to the present time grindstones have been exclusively employed.

MACHINE-TOOL DESIGN

By W. D. FORBES*†

The condition of a concern that has been in the machine building business for some years, and that of one about to embark in such a business, must, of course, be considered from two very different standpoints. Few, if any, established concerns will throw patterns, tools, or fixtures to the wind, take a clean sheet, and let the "dead past bury its dead." It is generally too much of a temptation not to use the 2 9/16-inch sixteen-thread tap which is on hand, although the new design calls for 2¾-inch, twelve threads; and it is difficult to remember that the 2 9/16-inch sixteen-thread tap was made nine years ago and is really "no size at all." The newly-born concern, again, can take a clean sheet, is not hampered by traditions, and can start and make its tap to the required size without feeling bad about it.

If machine-tool designing is engineering, it is safe to say there is less mathematical calculation of the design than in any other branches of the profession; here, tradition holds the field. The lead-screw of a lathe is made a certain diameter and pitch, mainly because other lead-screws are found to be of such and such dimensions, and not because there is any calculation made showing that the heaviest cut on the hardest machinable metal will result in certain maximum strains which should be provided for. The lathe bed is made so wide because one of the best lathes in the market has such a width, and, in fact, the calculations of machine tool stresses are far from concise, and the general assumption of designers is that if the part is made too strong nobody will find it out, while weakness will show and trouble result.

The developing of a new design is usually due to the fact that some rival concern has brought out a design which meets the demands of the market, and something must be done to make good the falling off of orders. Of course, somebody has to have originality. But it is not reasonable to suppose that a "going" concern, having all it can do to fill orders, will voluntarily undertake to design something which will, in a large measure, antiquate its own production. There are concerns which are wise enough to know that while to-day they lead the procession, they will fall behind if they do not "step lively" in the matter of improved construction and design. This means, of course, a large outlay of money, a great deal of work for all hands, close attention, and a certain amount of risk, because we all make mistakes in judgment, and at times designs that seem most admirable do not sell. For example, some years ago the writer saw a bolt cutter which cut bolts on centers. Its product was admirable, yet the first ten or a dozen machines did not sell, and a large proportion were carried in stock and finally broken up as uncommercial tools. On the other hand, a little mechanical hacksaw came on the market; it looked so light in design that there seemed to be danger that it would blow out of the window if open; yet the writer never bought a tool of any kind which gave such splendid money returns and was so useful as this little power hacksaw.

It should not be understood that the "cheapness" of a machine tool makes it an easy seller or a good commercial article; a really cheap machine is one which accomplishes what it is built to do at the minimum cost of operation and up-keep and which, when sold, not only stays sold, but sells others. It is, of course, out of the question to buy certain special tools, or what we call "single operation tools," when an establishment is run on a comparatively small scale, but this class of tools is being more and more thought about, and an entirely new system of machine-shop equipment can be conceived which would consist of a complete equipment of single-operation tools whose product would be far more satisfactory, both in quality and cheapness, than that of the present multi-operation tools, and which would cost about the same as the usual equipment. Certain standard tools cannot, of course, be dispensed with for the tool-room and for jobbing shops, but the writer thoroughly believes that a few years will see machine-tool builders equipping shops on a system of single-operation tools.

Tradition in machine-tool design is a very powerful factor, and one often wonders why certain things are continued, as, for instance, the form of the lathe lead-screw. In general, it is square threaded, but its function is to traverse the carriage 95 per cent of the time toward the headstock. It is rare to see the work being done from the head- to the tail-stock. In cutting a left-hand thread, of course, the carriage would travel toward the right and against the dead center. In the running back in right-hand screw cutting, the lead-screw has to carry only the carriage, and many times it is

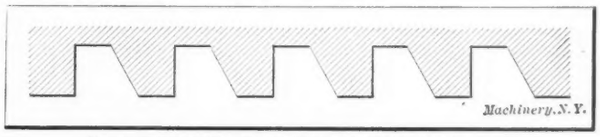

Fig. 1. Proposed Ratchet Thread for Lathe Lead-screws

run back by hand by the operator. It is, therefore, difficult to see why the ratchet form of thread, as shown in Fig. 1, is not used; this form of thread is successfully used in a vise.

Most lathes have an apron, back of which are the gears, clutches, worms, and wheels, all out of sight and out of reach. You have to lie down on your back to inspect them, and then you drip candle grease into your mouth, and can see very little. From oil holes in the apron, small tubes lead to the various bearings. A squirt-can is introduced into these holes by the machinist, who presses the spring bottom of the can with his soul filled with satisfaction, as he feels he has performed his whole duty as to oiling the apron by this action, and to all intent and purposes the bearings are oiled according to usual ideas. Now, we all know that they are not oiled by this operation. Why not put all the gears, etc., on the outside of the apron where they can be seen and cared for? Or, if the people object to dirt, why not put a piece of plate glass in front of these gears? And, again, why not have a central reservoir for oil, which can be neglected every six months instead of oftener, as are the various independent oil holes now in use?

The mere fact of a departure from recognized practice should not be considered unless it accomplishes something better, offers greater accuracy, speed of production, less cost, or greater wearing qualities. To-day there are many who believe that gearing will not permit of as fine work as a belt drive, yet the writer never saw a planer that was not driven by gear, except one—and that had a chain. One recalls no objection to gearing in this class of machine tool, and often wonders why. If gears are bad in a lathe, why are they not bad in a planer? The spiral gear drive used in some planers is also a form of gear.

For years we have been content to have a single speed supplied for all planer work, yet a lathe with but one speed would never sell at all. It is clear that the planer does not demand the variety of speed that the lathe does, but there is no question that its output is less than it should be because of the lack of possible speed variation. There are available speed riggings now on the market which are said to be excellent, but they are totally separate from the planer, are expensive, and somewhat bulky. What is required is a speed variation mechanism built into the planer. In shapers, which are nothing more nor less than a form of planer, variable speeds have always been provided, and in this particular class of tool the last few years have seen some most convenient modifications and vast improvements in design.

When Mushet steel first came into the market it met the foe of all new things—that is, prejudice. Its value was not

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* President, W. D. Forbes Co., New London, Conn.

† William D. Forbes was born at Perth Amboy, N. J. He was educated mostly abroad, in Switzerland, France and Germany, and is a graduate of the University of Zurich. He took a post-graduate course at the University of Dresden, Saxony, and worked for a number of Continental and British firms. After returning to America, he was employed by various firms, among them De Lamater, New York, and the Howard Iron Works, Buffalo. For three years Mr. Forbes was engaged as States' Engineer in the West Indies, and for the last twenty years he has been at the head of his own business, specializing on high-speed engines for marine work, steering engines, and other marine appliances. This business was first established in Hoboken, N. J., and eighteen months ago moved to New London, Conn., where an entirely new shop was built. Mr. Forbes is one of the governors of the Society of Naval Architects and Marine Engineers, and for many years he was on the New Jersey State Board of Education and vice-president of the local manual training board, having charge of the night schools. He has been a contributor to many engineering journals, among them *Engineering*, of London; *International Marine Engineering*, *The American Machinist*, and *Cassier's Magazine*.

grasped and could not be taken advantage of, as most machine tools were built light and would not pull the cut which could be taken with even the original carbon steel. To-day high-speed tool steels can be used to full advantage, but to the writer's mind it is not the ability to cut large quantities of stock which is its greatest value, but its wonderful lasting qualities. It is, of course, difficult to say to what extent high-speed steel has added to the value of a certain class of machine tools, but it is a very important factor in screw machine work, for instance, where form tools are used. The possibilities of turning out large quantities of work without regrinding the tools may augment the output many times.

In making any new design it must be remembered that too much novelty is expensive to introduce, and this extra expense must be counted on in selling; yet, a real novel feature assists in selling, as most people want to buy what is "up to date." It is safe to say that any new tool must have marked improvements over what has been made in the past

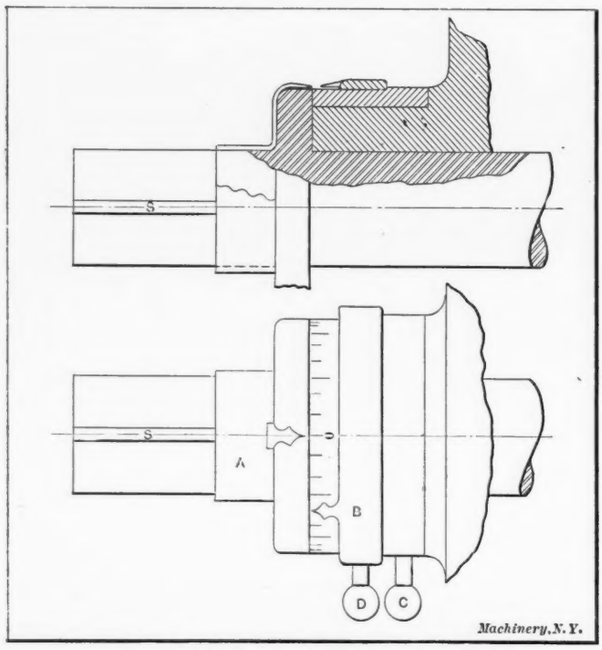


Fig. 2. Improved Micrometer Dial and Indicator for Feed-screws

few years, or its selling qualities will not be great. It must be capable of rapidity of production, ease in changing tools, power, and accuracy. Ease of handling is of great importance, as some very productive tools have been disappointing, in that they were "men killers." They were too heavy in operation, which made it difficult to find men to run them; and on this class of tool it is pretty well admitted that, instead of a very low grade of labor, a high rate of intelligence in the operator has proved more economical in production.

The operator's mental requirements must be considered by the designer, but he must remember that somewhere there must be skill in obtaining a product from any machine. All tools lose their cutting edge and when again ground require adjustment. The mere fact of bringing an edge to a stop is not sufficient for fine work, as a slight difference in keenness will vary the size of the article produced, and even a slight change of cutting angle may affect the results. The writer would call "bringing the tool to a stop" a rough adjustment, and the exact size and adjustment must be obtained by trial for accuracy.

Of late years a micrometer plate is quite often provided for the adjusting screws in various machine tools, and it is a very great advantage, as the machinist can use a micrometer and see to what extent he varies from the desired measurement, and this difference can be then adjusted almost exactly by the micrometer plate. The writer, however, finds fault with the divisions of the micrometer plates and has often wondered why they were not very popular among machinists. The reason is that errors are often made on lathes through the operator forgetting that if the work is one-thousandth inch large, he must only set his tool one-half a thousandth, or he will be removing two-thousandths inch of stock instead of one-thousandth. In other words, the micrometer plates on lathes should be graduated differently from those used, say, on a boring mill; but in both cases the little indicator, illustrated in Fig. 2, would prevent error. It is very much easier to adjust differences when the plate can be turned to zero and then the amount of movement made, but if the little indicator shown is simply turned back or forward the number of divisions required, and then the screw carrying the plate turned and the indicator brought to zero, fewer errors are made.

To explain more clearly: *A* is a pointer held by friction to the screw *S;* this pointer can, however, be turned to any position without turning the screw. We will suppose the arrangement is fitted to a horizontal boring mill, and that we want to shift the platen over four divisions. For convenience in reading, bring the pointer *A* uppermost; then by the handle *C* bring the 0-division of the plate to the pointer *A*, and by the handle *D* move the pointer *B* to the fourth mark. All that has to be done now is to turn the screw *S* with its pointer *A* until the pointers *A* and *B* coincide, and the platen will have been advanced four divisions.

It can, of course, be said that the pointer *B* is superfluous, as after the pointer *A* is made to coincide with the 0-mark, the division plate can be advanced four divisions and the screw then turned until the pointer *A* is again at 0; but this is somewhat confusing to do, as the divisions have to be counted to the left of the 0-mark, while the screw for its adjustment has to turn to the right.

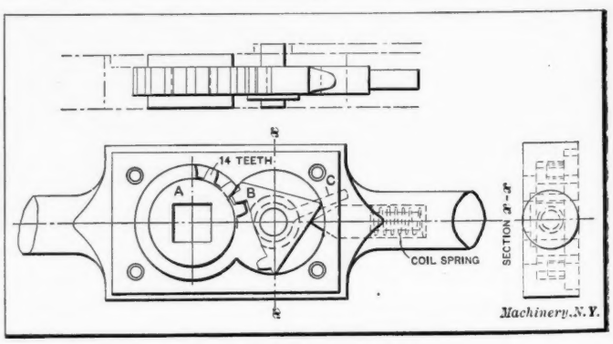
In practice, the machinist sometimes chalks the divisions, with more or less clearness, or resorts to scratching the division plate, or even using a prick punch. This pointer *B* is an error preventer.

In this article, of course, it has been impossible to any more than suggest to designers certain ideas; but, after all, is not a suggestion better than concrete information, as the latter would probably only be adapted to one case, while a suggestion can be general. In concluding, attention should be drawn to one more thing, and that is that builders of machine tools could, at very little cost, stamp on the name-plate the range of the tool.

* * *

RATCHET TAPPING WRENCH

A short illustrated article describing a ratchet tapping wrench used by the Société Anonyme des Ateliers de Construction H. Bollinckx appeared in the June number. The accompanying illustration, supplied by the company, shows



Bollinckx Ratchet Tapping Wrench

the construction. The socket *A* for the tap square is made like a gear pinion with square hole, having fourteen teeth of characteristic gear-tooth forms. A two-toothed pawl *B* engages these teeth, being thrown by the workman in either direction as desired, by the lever *C*, shown in dotted lines.

The advantage of the rachet tapping wrench, as set forth in the previous article, is that it prevents the workman turning the tap backwards when tapping a hole. The backward movement rapidly dulls the cutting edges and breaks the teeth. When the hole has been tapped, the workman can reverse the ratchet and remove the tap the same as with an ordinary tapping wrench.

MILLING AND DRILLING OPERATIONS ON THE ELLIS ADDING TYPEWRITER

By RALPH E. FLANDERS*

In last month's number of MACHINERY the Ellis adding typewriter was described in some detail. Some idea was also given of the systematic procedure by which it was invented and developed. This same orderliness is also apparent in the manufacturing operations, as will be seen in this and subsequent articles dealing with shop practice at the Ellis Adding Typewriter Co.'s factory in Newark, N. J.

As an illustration of the methods pursued in the milling and drilling operations, the machining of the side frames is here illustrated and described. Rough and finished examples of these frames are shown in Figs. 1 and 15. They are flat, ribbed castings, on which a number of milling cuts are taken, and in which a great number of holes are to be drilled, reamed, counterbored, countersunk, tapped, etc., requiring a great variety of operations. The right- and left-hand frames are somewhat different in design, although the character of the work to be done is the same on each.

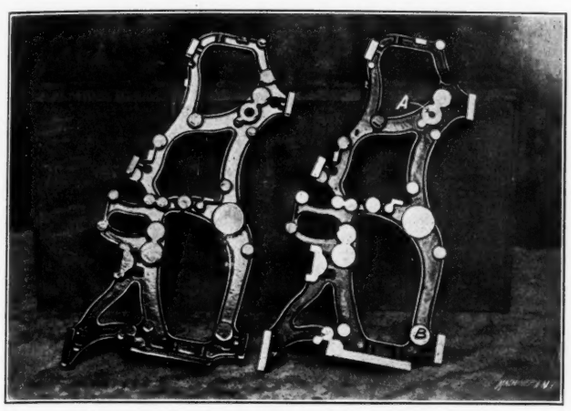


Fig. 1. The Japanned Side Frames before and after Surfacing on the P. & W. Vertical Grinder, showing Center Spot for Locating First Drill Hole

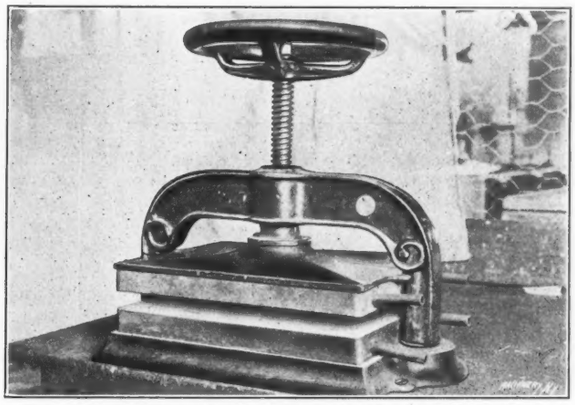


Fig. 2. Letter Press fitted with Water-cooled Platens for Straightening Side Frames preparatory to Grinding

The first machining operation to be performed is the finishing of the sides. In the original design the bosses and feet were of different thicknesses for different parts of the frame, and these surfaces were face milled on the profiling machine. This operation did not prove entirely satisfactory, however. It was too slow, for one thing. Besides this the cutting action was localized and the work was, in consequence, unevenly heated, causing it to spring so that it was difficult to keep it of an even thickness over the whole length of the piece. It was decided, therefore, to reduce the finished thickness to the same dimensions all over, and to finish these surfaces by the operation of face grinding, which would cover the whole extent of the piece at one sweep, thus diffusing the heat generated and doing away with the distortion.

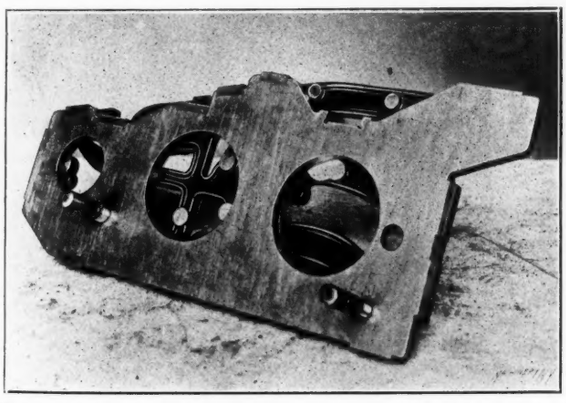


Fig. 3. Templet used for Setting Cutters and Testing Finished Surfaces for all Milling Cuts on Both Right- and Left-hand Side Frames

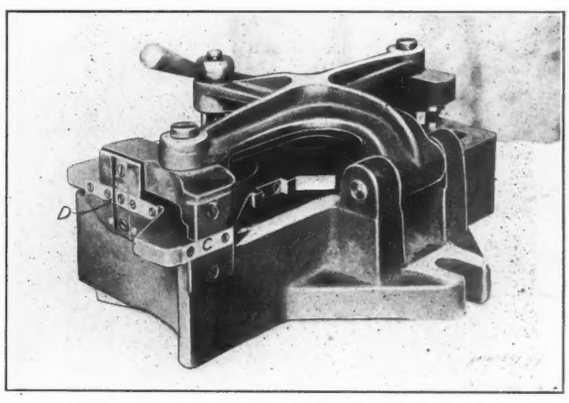


Fig. 4 The First Milling Jig with Templet in Place for Setting Cutters

Straightening the Frames

In order to get the greatest economy from the grinding operation, the stock left to finish was reduced to the least possible amount, so only 1/64 inch on each side, or 1/32 inch in thickness overall, was left on the rough casting. With so slight an allowance it often happens, of course, that the castings come warped slightly, so that they will not machine out. It thus became necessary to devise some means of straightening the frames. This straightening was done in the letter press shown in Fig. 2.

This letter press, as may be seen, is provided with upper and lower water-jacketed platens, through which a constant circulation is maintained. Those frames which are too crooked to finish out are heated in an ordinary gas furnace to a "cherry red," and laid in the press, which is then tightened down on them. They cool to the temperature of the circulating water almost immediately, and when so cooled are found to be straight enough for all practical purposes, though a surface plate is provided for testing them, and a second heating given if necessary. This straightening operation, which is a matter of a very few seconds, results in a great saving of time over what would be necessary if enough finish were left on to avoid this press job. Straightening is, in this case, much quicker than grinding or any other form of machining.

An interesting difficulty was encountered in this straightening apparatus and had to be remedied. The men on the drill presses claimed that certain of the frames appeared to have a chilled surface on one edge which raised havoc with the cutting edges of the drills, in breaking through the skin. A little detective work showed that this chilled surface was found only in frames which had been straightened in the manner we have just described. Still further investigation showed that the workman who did the straightening was accustomed to place the work in the press the same side first each time, and the only part that was chilled was that close to the inlet pipe of the water-jacket platens. It was, therefore, concluded that the cooling of the iron from cherry red down to nearly the temperature of the water was sufficient to chill the metal.

This difficulty was overcome simply by throttling the inlet water until it moved so slowly that it attained practically the boiling temperature near the inlet. The drop in temperature from the cherry red to about 212 degrees appeared to be enough

* Address: Springfield, Vt.

to straighten the casting, but not enough to chill or harden the metal.

The frame (after being thus straightened, if necessary) is japanned. One side is then roughly faced on a Gardner vertical-spindle disk grinder, to give a smooth surface for the magnetic chuck to take hold of. The work is next taken to the Pratt & Whitney vertical spindle surface grinder, where it is laid on the magnetic chuck and each face has about 1/64 inch removed from it, surfacing the sides up to exactly the required thickness. Only a few passes of the wheel are required for each surface. This method of finishing has proved to be the best and the cheapest yet tried for the work.

Drilling the Gage Holes

Every operation on these frames is located from two of the holes which are common to both the right- and left-hand frame, or from one of the holes and a milled edge located from them. These holes are drilled with reference to the rough casting, and thus locate all the other holes and the milled surfaces with reference to the rough casting. Under these conditions, when the casting does not finish out, it is considered to be defective and is discarded.

The first of the two gage holes is drilled without using a jig

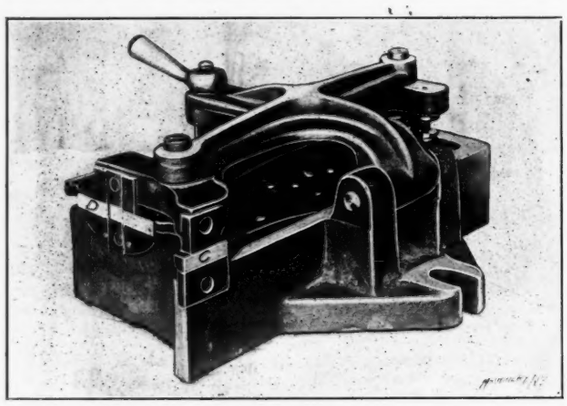


Fig. 5. First Milling Fixture with Work in Place

or fixture of any kind. In Fig. 1 it will be seen that one of the bosses, *A*, at the upper end of the frame, has a center hole cast in it. This is more plainly seen at the right, where the japan with which it is filled shows dark against the ground and finished surface of the boss. This locates the first hole. The work is simply taken to the table of the drill press, is drilled through and reamed. The cast center hole or countersink locates the hole with reference to the casting, which is what is required at this point. Everything else is brought to agreement with this.

The second gage hole is drilled in a simple jig (not here illustrated) which locates the work on a stud entering the first gage hole, and against a suitably chosen contact point on the casting. This hole is drilled in the boss shown at *B*. The castings, with their gage points thus located, are now ready for the regular jig and fixture operations.

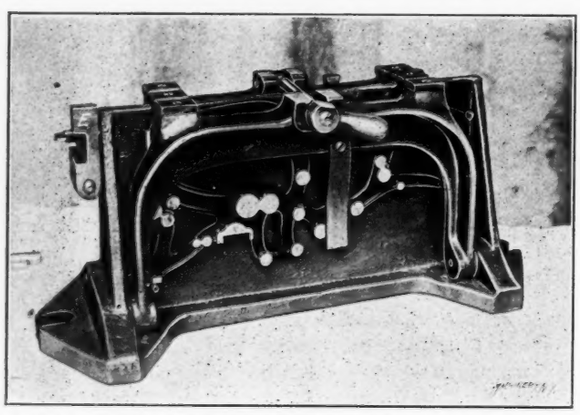


Fig. 6. Double Knee Fixture for Milling the Foot Surfaces of Two Side Frames simultaneously

The Edge Milling Operations

The milling cuts on the edges of the frames are the first to be taken. For setting the cutters in taking these, and for testing the work as well, a gage or templet is provided, shown at Fig. 3. This is made of cast iron, of the same thickness as the side frame (5/16 inch), and is provided with several inserted hardened steel plates or gages. These are of the exact dimensions, and in the exact positions with relation to the gage holes, to agree with the various milling cuts. Some of the gage surfaces, as may be seen, apply to the frame

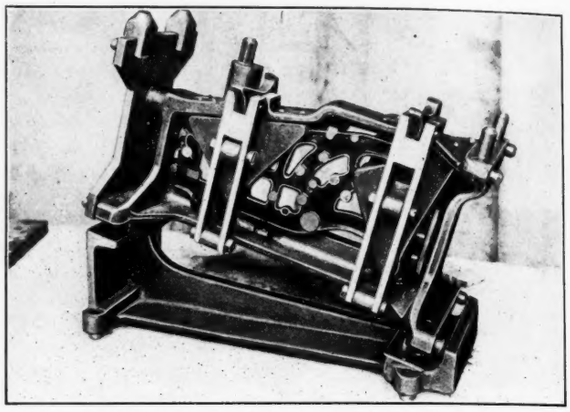


Fig. 7. Jig for Drilling Edge Holes in the Side Frame, Provided with Angle Knee as shown for Drilling Inclined Holes

shown laid against the gage, while others do not. Two plugs are shown in place, passing through the gage and the gage holes in the work, locating them properly with respect to each other.

The fixture for the first milling operation is shown in Fig. 4. This is a gang milling operation, which finishes the flat surface at *C* and the tongued surface at *D* simultaneously. The templet is shown in place. The fixture is mounted on the table of the milling machine, and the gang of cutters is set on the arbor so as to accurately match the hardened surfaces of the gage. When so set, the gage is removed and the

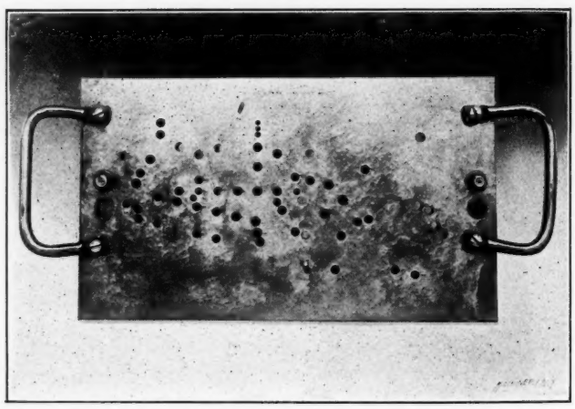


Fig. 8. Master Plate for All the Holes in Both Right- and Left-hand Side Frames—Holes Common to Both Frames are bored through

work is inserted in the same position and held in the same way, as shown in Fig. 5. The same studs in the fixture which locate the gage locate the work. The fixture holds the work down at four points. A swinging clamp arrangement is used, controlled by a single lever nut and swinging bolt, as shown. This holds the work firmly, and gives the solid foundation necessary for accurate cutting with a reasonable rate of speed. The table is fed vertically in this case. The fixture might have been set up horizontally, so that the longitudinal feed could have been used, but owing to the length of the work, this would have required setting the cut at a considerable height above the table, inviting chatter and inaccuracies of various kinds.

The next and last milling operation is performed in the fixture shown in Fig. 6. This is of the knee type, but is so arranged as to hold a piece of work on each side, so that two pieces are finished at one cut. The two swinging clamps

are tightened down against the work and the knee by a single swinging bolt and handle nut, as shown.

At *E* is shown a gage, which was provided for setting the table to the proper height in this jig before the templet shown in Fig. 3 was devised. This gage has a hardened upper surface, set at exactly the height of the cut to be made in the work. The milling machine table was brought up until the cutter would just bite a piece of tissue paper held between it and the top of this gage. After thus setting the cutter the gage was swung down out of the way, it being pivoted as shown. It is just as convenient, however, to use the templet shown in Fig. 3, mounting it on the gage pins in place of the work.

The templet is used for testing the various milling cuts. It is located against the face of the work with plugs, as shown in Fig. 3, and then a square is laid against it to determine whether the edges of the gage and of the work are flush. A little experimenting with a piece of thin tissue paper serves

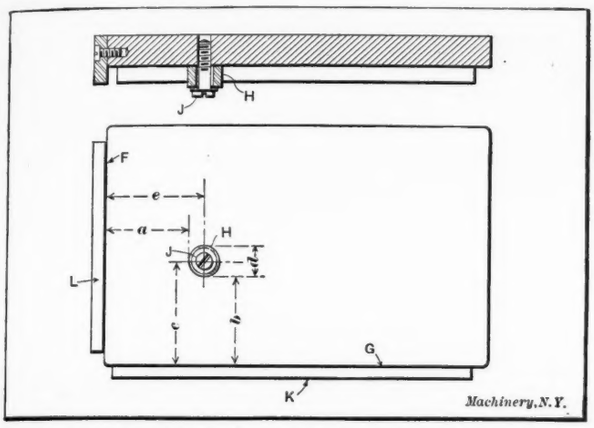


Fig. 9. Locating Holes in Master Plate with Gage Strips and Buttons

to show where and how much the surfaces are out of line with each other.

Drilling the Holes in the Edges

The first drilling operation takes care of all the holes in the edges of the frame, all the way around. The jig shown in Fig. 7 is used for this work. This is of the cast-frame type, as shown, and is provided with four legs on each of the four faces about its periphery, all of these faces being used. Suitable hardened bushings are provided for each hole. The work is held in place by two swinging clamps, each provided with a three-footed equalizing clamping pad. The work is

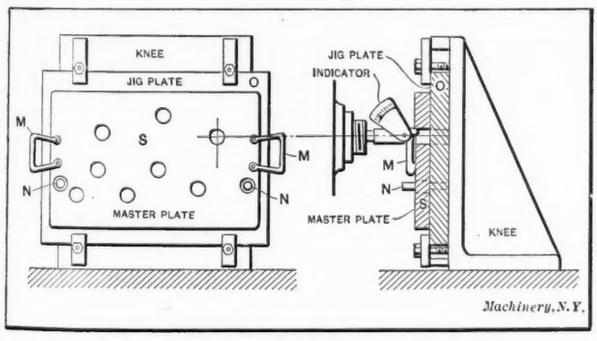


Fig. 10. Transferring Holes to Jig from Master Plate

thus held in place by pressure applied at six points. It is located, of course, by studs fitted to the same gage holes as in the preceding operation.

The holes in the bottom and ends are vertical and horizontal, at right angles to each other. There are, however, a number of holes in the inclined top edge which are drilled at an angle, and provision has to be made for this. This provision consists, as may be seen, of a simple angle fixture into which the jig is set, bringing work and jig to the proper position for drilling these inclined holes.

The work is now ready for drilling the multitude of holes in the sides. Some of these holes are common to both right- and left-hand frames, being supports for shafts, rods, etc., passing through the whole width of the machine. Others are used on one frame only. Some of the holes are simply drilled, some are drilled and reamed; others are counterbored, countersunk, tapped, etc. An immense number of operations is required on these holes for each piece.

The Making of a Master Plate

All of these holes, for both side frames, are located from a master plate which is shown in Fig. 8. Such of these holes

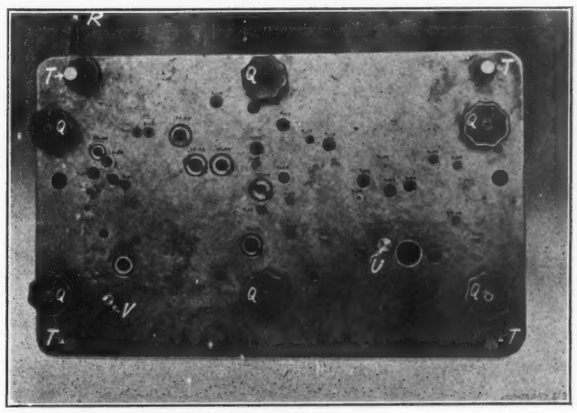


Fig. 11. Master Jig for Right-hand Side Frame. The Holes in this Jig were located by the Master Plate shown in Fig. 8

as are common to both frames are bored through. Holes intended for the right-hand frame are only bored half way through from the right side, while the left-hand holes are similarly bored half way through from the left side.

The method of laying out and boring the accurately located holes in this plate will be understood from Fig. 9. The first thing to do was to obtain a plate of soft, close-grained and well-seasoned cast iron, 7/8 inch thick, machining it on both sides, and being particularly careful to have edges *F* and *G*

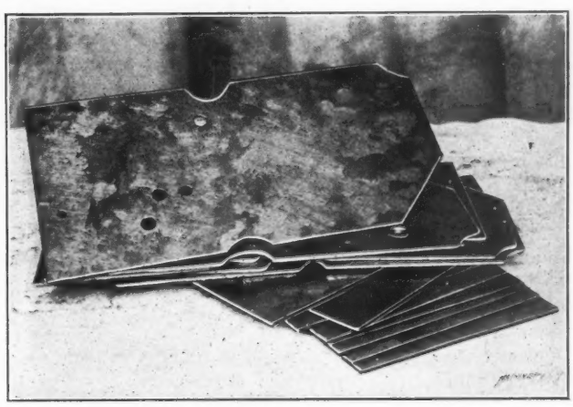


Fig. 12. Set of Mask Plates used for Locating the Holes to be drilled in Each Operation on the Side Frame

at right-angles to each other and square with the faces. Getting these edges square with each other and with the faces of the plate is a vital point in the usefulness of this device, as will be seen.

The various holes are located by jig buttons, one of which is shown at *H* in Fig. 9. This method, of course, is the common procedure for such work. The button is of any convenient diameter, accurately lapped, and with faces ground square with the axis. It is located approximately in the place desired for the hole, by a screw *J* passing through it and tapped into the face of the plate. The button or bushing is loose enough on this screw so that it may be adjusted slightly to bring it to the exact position required.

To bring it to this exact position required, strips *K* and *L* were screwed to the accurately finished edges of the master plate. Measurements *e* and *c* were given by the lay-out furnished to the toolmaker. From each of these dimensions was subtracted ½*d*, giving measurements *a* and *b*. These measurements were then taken with an inside gage between the

sides of the button and the inner edges of the gage strips. The button was clamped by these measurements in exactly the required position. The plate was then mounted on a precision knee on the milling machine, and the bottom was located exactly concentric with the axis of revolution of the spindle. A test indicator mounted in the taper hole of the spindle was used for this. While in this position a hole was then drilled and bored to any suitable diameter. Care was taken, of course, that the work was done on a milling machine having accurately fitted boxes and sliding surfaces, so that no change in position could take place when drilling and boring.

Each subsequent hole in the master plate was located from the draftsman's lay-out in the same way by screwing a button on the plate at the approximate position, and locating it accurately by a vernier height gage from strips *K* and *L*. These

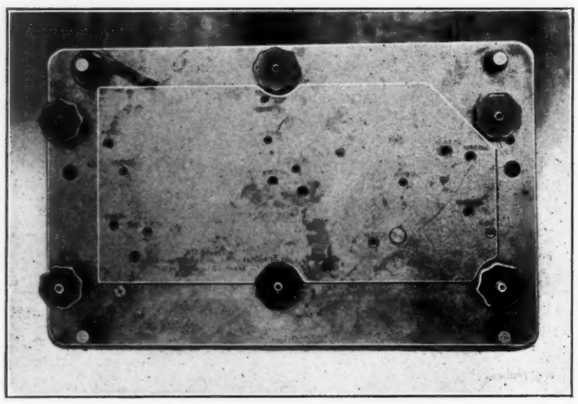


Fig. 13. The Jig shown in Fig. 9 with a Mask Plate mounted on it ready for the Multiple-spindle Drill

strips were wide enough to extend beyond the plate on each side, so that the blind holes on each side were properly located with reference to each other and to the through holes.

Making a Jig from the Master Plate

One of the jigs, for the making of which this master plate was used, is shown in Fig. 11. This contains, it will be seen, a great number of holes of various sizes, bushed with hardened steel. These holes were all laid out from the master plate in the manner illustrated in Fig. 10. The plate is here provided with handles *M* and with gage pins *N*, as shown in Figs. 8 and 10. The cast-iron plate *O* has had drilled and reamed in it holes to receive gage pins *N*. These holes, as well as those in *S* which receive pins *N*, were drilled with a supplementary jig, so that a good fit of the pins in *O* is assured.

This jig plate *O* is clamped to the knee of the milling machine in position to have the different holes drilled and bored. The first thing to do is to fit the master plate onto the jig plate, where it is accurately located by gage pins *N*. The cross and vertical adjustments are then set so that the hole in the master plate which it is desired to transfer to the jig plate is exactly concentric with the axis of revolution of the milling machine spindle, as shown by a test indicator mounted in the spindle. When this adjustment has been accurately made, the gage plate is taken off from the jig plate, and the desired hole is drilled and bored in the latter. The master plate *S* is then replaced on *O* and the next hole is centered with the spindle in the same way, and drilled and bored in the jig plate.

Any holes in the master plate may thus be transferred to the jig plate with definite assurance that they will all be the proper distance from each other; and this assurance is obtained without the necessity of making any measurements whatever, or of employing any operation that might result in a mistake of any kind. When the master plate is once made right, and is inspected and found right, it may be used in this way to transfer any number of holes to any number of jigs in a way which gives the greatest accuracy with the least work and worry.

The completed jig, shown in Fig. 11 and again in Figs. 13 and 14, is provided with feet *T* on both sides, and with gage pins *U* and *V*, which also extend through both sides. The larger pin *U*, enters one of the gage holes of the work, while the finished edge rests against the smaller pin *V*. Hook clamp screws *Q* are reversible, as is cam *R*, which forces the work down against pin *V*. It will be seen from this that the work may be held on either side of the jig. This is required, because it has been found good practice to drill each hole through from the side on which the hole has to be matched up with other parts. This obviates even such slight errors as might occur from the creeping of the drill or reamer in passing through the 5/16-inch thickness of metal in the frame.

Various Methods of Drilling in Manufacturing Works

Now there are several ways of using such a jig as this, depending on the number of pieces per year for which it is to be used. The work, for instance, might be clamped in place and all the holes drilled at a single setting, changing the tools constantly as required for the different sizes of holes, and for the different taps, reamers, counterbores, etc. This method of working, however, would only be fit for making one or two or a half dozen pieces at a time. For quantity production and continuous use, it might be better to provide elaborate multiple-spindle drilling heads, drilling all the holes simultaneously if possible; or, if some of the holes are too close together, drilling them in two operations to avoid interference. Or, finally, one of the highly specialized automatic machines for this work might be used, in which the work is carried from one multiple-spindle head to another, for performing the whole series of operations at one setting.

The method used in this shop at present is a compromise between the two possible extremes. It was decided on as being the most satisfactory procedure for beginning manufacturing, where the lots are comparatively small, and the rate of production not up to the amount expected when the factory gets into full swing. The compromise is a highly interesting one, and does great credit to the ingenuity of the shop manage-

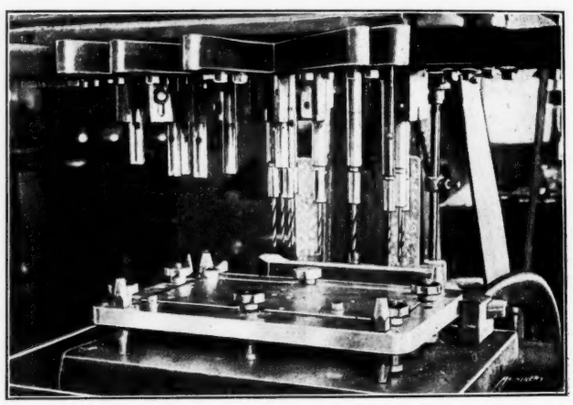


Fig. 14. Jig with Mask Plate in Place on the Table of the Multiple-spindle Drill. Note the Gage at the Back for Locating the Jig

ment. The principle of it is illustrated in Figs. 12 and 13. A sixteen-spindle drill is used, of the type shown in Fig. 14.

The Use of Mask Plates for Multiple Drilling

The tool designer goes carefully over the drawings of the work, and segregates the holes and operations into groups of not more than 16, taking great pains to see that the holes in each group are of approximately the same diameter, and are not too close together for the minimum center distance of the spindles. Mask plates, of which a number are shown in Fig. 12, and of which one is shown in place on the jig in Fig. 13, are then made, one for each of these selected groups of operations. These plates cover up everything except the holes to be drilled in each of these operations. The holes are roughly laid out and roughly drilled, the masks not being used in any way, of course, to guide the drill itself. The plates are thus very cheaply made from 1/16-inch sheet steel. Each hole is stamped with the name, size, etc., of the drills, reamers, etc., required, so that a mistake is inexcusable.

If the work should be desired in larger lots, requiring more jigs to permit several operations to be done simultaneously, these new jigs would be made from the master plate in the way shown in Fig. 10, very much more cheaply than would be possible if they had to be measured up from the beginning. For the present, however, this set of mask plates with four jigs

(two for each side frame) gives enough of a supply to meet the requirements of production. It is probable that in the future, as production increases, drills having special multiple-spindle heads will be provided, each carrying 25 or 30 drills, counterbores and other tools. When that is done, the masks will be made to correspond, or new special jigs will be made for each operation.

The Use of the Metric System

It may be a matter of interest to state that the metric system is used in this shop. It has been found to have advantages in some respects, and disadvantages in others. It has required a somewhat increased expenditure in the matter of standard small tools in some cases; this has not been as great as might be expected, however, since practically everything in the way of reamers, taps, counterbores, etc., has to be special in any case. It is on the tool work that the greatest difference in the use of the metric system is noticed, rather than in the manufacturing, as the tendency is to provide special gages and measuring tools for all manufacturing operations. Since the machine tools were not bought with metric lead-screws, the index dials on the milling machines, etc., of course, are useless, requiring a slight increase in the length of time needed in setting up the machines.

There has been one point of advantage in the use of the system which is purely psychological. Apparently the workmen, after a little training, find it as easy to work to hundredths of a millimeter as to work to thousandths of an inch.

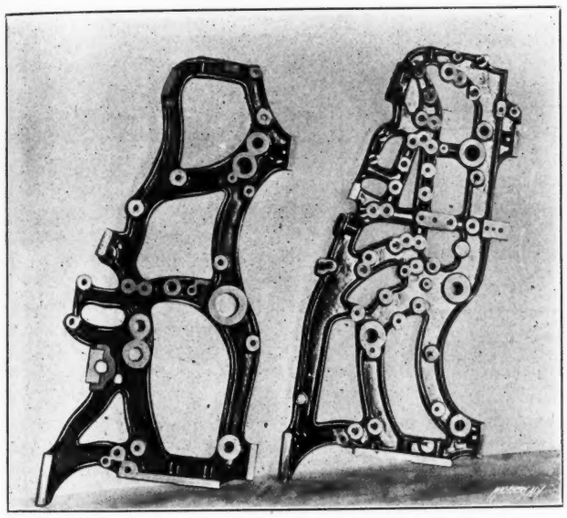


Fig. 15. The Completed Side Frame—Right- and Left-hand Sides

In each case it is merely the question of working to certain graduations on a micrometer or vernier. Since the metric subdivision is less than one-half that of the English measurement, it has been found that the same workmen, when the metric system is used, tend to do rather more accurate work than before, without realizing it.

The points of particular interest described in this article which are worthy of the attention of mechanics as being of wide application, are these: The practice of straightening soft iron castings before grinding, thus saving the time that would otherwise be necessary to remove an excess of material; the use of countersunk holes, cast into the work, for locating the first drilling operation with relation to the rough casting; the use of a templet, interchangeable with the work in the jigs and fixtures, for setting cutters and for testing the work; the use of a master plate for duplicating jigs; the use of mask plates with a master jig, so laid out as to group together holes of nearly the same diameter, permitting multiple drilling to be done to the best advantage.

This is, it will be agreed, a very creditable list of items of improved practice for a job as simple, comparatively, as the work on these side frames. It is, however, only one evidence of the attention to detail which Mr. Ellis, the inventor of the machine, Mr. MacFarland, the superintendent, and Mr. Perkins, the tool designer, have given to the whole process of manufacture.

ECONOMICAL TOOL DRESSING AND GRINDING*

By JOHN BRANDLE†

John Brandle‡

In the majority of shops tool dressing and grinding has become an exact science. The tools are dressed and forged by means of formers so that the exact shape desired is obtained, in order that in grinding no more stock is removed than necessary. The tools are ground on tool grinders with the least expenditure of time and material, and with the view of getting the proper cutting angles for the work to be performed.

This article is not written for those shops which are efficiently equipped, but is intended to help correct the waste and loss which occurs in most engineering and railroad shops, particularly in those districts where the tool grinder is considered a waste of money and space. In these shops you hear the expression, "We could not use anything like that because no two machinists grind their tools alike." What they really mean is that no two machinists grind them right, being allowed to grind them their own way by the foreman, who should know better, and generally does know better, but is careless. This carelessness on his part increases the cost of tool dressing, decreases the efficiency of the tool and causes a waste of material that is surprising.

As an example of this take the common round-nosed tool 5/8 inch by 1¼ inch by 8 inches long shown in Fig. 1. When received from the forge shop the mechanic grinds the tool to the desired shape, and after it is dull retains the proper shape by grinding it on the top as shown in Fig. 2, thereby following the line of least resistance, as he knows it to be or has been taught. Now let us see what occurs by pursuing this method. After the tool is ground down about half way it becomes too weak to stand up under a heavy cut and must be re-dressed. In order to dress this tool the material shown at the right of the dotted line, Fig. 2, must be cut off, and is a total waste. On a tool eight inches long, the usefulness of which is five inches of its entire length, this method would only allow the tool to be dressed from six to eight times. On a tool of this size the writer kept an exact record with the following results:

6 dressings of the tool at 40 cents each.....$2.40
Weight of metal cut off, 1/4 pound high-speed steel, at 75 cents per pound. Total cost of wasted steel..... 1.125

Total cost of dressing the tool..... 3.525

This was an average cost and some careless workmen ran it up still higher. On larger tools for both planer and boring mill work the cost increased in proportion to size, the increase in cost depending on the amount of metal cut off. We tried to utilize some of this waste stock by forging it into small square bars to be used in toolholders, but it proved unsatisfactory as the steel buckled in drawing out and broke off easily, and

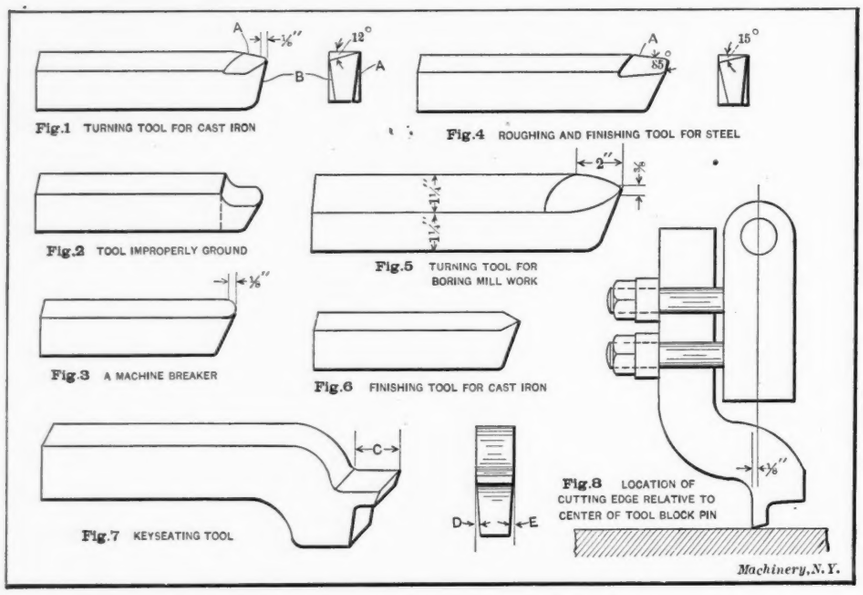
* The up-keep practice for lathe and planer tools as recommended by Mr. Brandle differs radically in one respect from that recommended by Mr. F. W. Taylor in his paper "On the Art of Cutting Metals," read before the American Society of Mechanical Engineers, December, 1906 (see MACHINERY, January to August, 1907, inclusive), in respect to forging. Mr. Taylor laid stress on the proper forging of lathe roughing tools to save grinding and steel. He recommended that the end of the tool be bent and turned up, and carefully shaped to a templet, and gave elaborate directions with illustrations for carrying out his method. With proper forging and grinding practice, the amount of steel wasted with Mr. Taylor's system is not as much as with Mr. Brandle's plan. However, the latter has the merit of being simple and easily administered, and is economical as compared with the wasteful practice all too common in many shops. No doubt it would work well in many comparatively small shops resulting in a substantial saving of tool dressing labor and steel, and increased efficiency of cutting action.

† Address: 331 N. Cumberland St., Jackson, Tenn.

‡ John Brandle was born in New York City, N. Y., June 29, 1879. He received a high-school education at the East Side High School and also attended night school in the Ohio Mechanics Institute, Cincinnati, Ohio; and has completed an engineering course in the International Correspondence School. He served an apprenticeship with the Lane & Bodley Engine Works, Cincinnati, Ohio, and has since worked for the Gray Planer Co., Cincinnati Milling Machine Co., Fosdick & Holloway Drill Co., Lodge & Shipley Machine Tool Co., all of Cincinnati, and the Garvin Machine Co. of New York, as machinist toolmaker and foreman of screw machine department. At present he is foreman of the saw mill department of the Southern Engineering and Boiler Works, Jackson, Tenn. His specialty is systematizing general machine work.

the cost of working it up in this shape was greater than the price of the bar steel.

The unnecessary cost of forging was reduced by having apprentices grind the tool, which extended the life of each tool over one year. This was done without the aid of the tool grinder by merely grinding the tools in the usual way on an emery wheel. In the first place, the proper cutting angles were selected for the class of work to be done, and then the tools ground to their proper shape. After that the boys were taught to grind them only on the front faces as shown at *A* and *B*, Fig. 1, for all round-nosed tools, both straight and bent. This method was continued as long as the tool lasted requiring no more dressing, the 40 cents expended being charged to hardening the tool as it wore back. Round-nosed tools were ground so as to present the least cutting surface to the work. Figs. 1 and 3 will readily explain the reason for this. In order to take a cut 1/8 inch deep with a tool 3/4 inch wide ground as shown in Fig. 3, the tool would present at least 1/2 inch cutting surface which on a small machine would cause an enormous strain being put upon the feeding mechanism when the tool became dull. It is a fact that the majority of ruptures and breakages of machine parts, can generally be traced to the tool being ground as shown in Fig. 3. In Fig. 1 it will be noticed that in order for the tool to take a 1/8 inch depth of cut, there is less than 3/16 inch cutting surface. The point of the tool should be ground wider than the width of feed in order to leave a smooth surface for a finishing cut. The reason is therefore obvious why manufacturers fail to obtain the results promised for high-speed steel tools, because when the tools are not ground properly the machine will not pull even an ordinary cut.



Figs. 1 to 8. Correct Methods of Grinding Cutting Tools

By standardizing the tools it was found unnecessary to carry a large variety of bar steel in stock. This was accomplished in the following way: For lathes between 16- and 20-inch swing inclusive, 5/8 by 1 1/4 inch tool steel was selected; for lathes from 24- to 30-inch swing, 3/4 by 1½ inch tool steel was used. Then the toolpost rings were cut down or made thicker, so that when the tool was set on a horizontal line, the top face of the tool was 1/8 inch below the lathe center. This was done in order that facing, cutting off and threading tools when elevated to their proper height, *i. e.*, to the center of the lathe, would have just enough top rake to make them cut easily.

The boys were also told to see that the bottom of the tools were straight. This was accomplished by grinding them on the side face of an ordinary emery wheel. If this is not done and the tool used as it comes from the forge shop, it will sometimes be found to rest only upon one or two points, so that it will require but little force to move the tool; and the men will tighten the toolpost screw to the breaking point or else will take a light cut, blaming it on the machine. After numerous experiments the writer found the proper cutting angle for the top face to be 12 degrees for cast iron (see Fig. 1), and the side and front clearance was found to be from 5 to 20 degrees depending on the diameter of the work. A very cheap gage was made from 1/16-inch sheet steel and supplied to each boy, as cast iron was used in the construction of the machines more than any other material.

Tools for turning steel were ground as in Fig. 4, and given a top clearance of 15 degrees, and the side *A* ground straight presenting no more cutting surface than the depth of the cut. This tool saves the time required for changing the tools and for squaring the shoulder with a facing tool. The corner is rounded to prevent it from wearing; this also enables it to be used for both roughing and finishing cuts. These tools when dull were ground similarly to the round-nosed tools for cast iron and made to hold their shape by grinding on the faces, requiring no more dressing, but merely hardening them again when necessary.

Ordinary planer tools were made from 3/4 inch by 1 1/2 inch, and 3/4 inch by 1 3/4 inch stock. For heavy planers or lathes the tools were made from 3/4 by 2 inch stock. The tools 1 1/2 inch square which we had previously used were discarded, because they were found to be practically no stronger than the 3/4 by 1 3/4 inch tools, and at the same time contained about 71 per cent more material. The top clearance was ground the same as the lathe tools, and the side and front clearance just a little more than was necessary for these parts to clear the work, thereby leaving the section at the cutting edge as strong as possible.

Tools for boring mill work were made from 1 1/4-inch square stock and forged as shown in Fig. 5. The dimensions shown here give the best results. If the point is drawn out more, the cutting edge will stand too far from the body of the tool causing it to spring and producing chattering. The same system of grinding was applied to these tools also, and when the tools became blunt it was necessary only to draw them out again to their proper shape, no stock being wasted. The writer has seen a tool of this kind ground down as shown in Fig. 2, and when sent to the forge shop in order to dress it, the weight of stock cut off was a fraction over 3/4 of a pound. Our blacksmith foreman showed me the cuttings of tools for a period of six months which were dressed under the old system, and the weight totaled over 100 pounds. This was mostly high-speed steel, Novo, Midvale, and Allen's, which cost 75 cents per pound.

For facing cast iron the straight pointed tool shown in Fig. 6 gave the best results, as it finished the surface truer than the ordinary facing tool and also required no forging.

Another tool standardized was the key-seating tool shown in Fig. 7. This tool was used exclusively for keyseating crankshafts, set-shafts for saw mills, saw mill mandrels, etc. It was forged so that its cutting face was 1/8 inch ahead of the center of the tool block pin (see Fig. 8). It was found that if it was set back further than this, it would not lift out of the cut, when cutting between the ends of the shaft, and if not given enough set it is liable to spring into the cut. The length of the portion *C* was made from 1 to 2 inches long depending on the width of the keyseat, and was ground straight the same size as the keyseat to be cut. It will be found that most machinists grind tools of this type with a little clearance, fearing that they will tear. Then when the tool is ground two or three times it is too small, necessitating taking two cuts or re-dressing the tool. If the tool is given five degrees clearance on each side as shown at *D* and *E*, Fig. 7, sloping toward the back end, the front cutting edge can be kept keen by occasionally whetting it with a good oil stone which

makes a smoother job, and the tool will also last longer than by just grinding the front cutting edge. This rule will apply also to cutting-off tools. The writer has seen a tool as above described which cut keyseats in set-shafts totaling 215 feet long by 1/2 inch wide and 7/32 deep, without necessitating removing it from the tool block for grinding. This tool holds its size 2/3 of the length of the portion *C* before it is necessary to have it re-dressed.

The methods given resulted in a saving for the first year both in steel and dressing that was simply astonishing. It was accomplished by sticking to the following principles, which seem almost too simple to write about, and yet they are being neglected daily:

1. Selecting the proper shape of tool for the work.
2. Keeping the proper shape throughout its entire length without re-dressing, if possible.
3. By teaching apprentices (who really took hold better than the older mechanics) to grind the tools correctly by one who knew how and encouraged them to do so, also making them adhere to the rules by close watching. This latter is the most important of all. No system no matter how complete and perfect is worth anything if the human equation is left out of the question. It was also found possible to grind the tools after forging without drawing the temper. This was accomplished by grinding on a small emery wheel, having close at hand a small tank for holding a sufficient quantity of water.

The writer has just taken up the ordinary tools which are mostly used in machine shops, and endeavored to explain them in clear and everyday language without technical phrasing, so that it may be understood by all. This method has been installed without any confusion and with the appliances usually found in large and small shops. "It should be very simple" you will say. It is, after it is installed and in good working condition, because it is the best and easiest, but for one year you will find it will take the closest attention and patience to bring it about. But after that period is over the men would not change back to the old system. The increase in output and decrease in the cost of tool steel used, the reduction in wear and tear of belt and breakage of machinery resulting from this, will make you feel that it is worth while.

* * *

THE PROBLEM OF AUTOMATIC STABILITY OF AEROPLANES

It is claimed that the problem of automatic stability of aeroplanes has been solved by Lieutenant J. W. Dunne, of Farnborough, England. At the trials the machine rose to a height of about 60 feet and then flew for a distance of about two miles without the touching of a lever or wheel, the machine during the whole time being in absolute equilibrium. The machine is a biplane, the most remarkable feature being the absence of a tail and steering surfaces or rudders of any kind, with a single exception of a couple of small steering flaps hinged to the rear extremities of the upper surface for the purpose of altering the course of the machine during the flights. The carrying planes are provided with a double curvature which, it is claimed, produces the automatic stability.

* * *

COLLECTIVE OR SELECTIVE CATALOGUES

Collective catalogues are made up of separate sheets, fastened together with ordinary wire staples or by other means that are selected according to the demands of the prospective customer or to what the manufacturer or dealer thinks would interest the recipient. Very often, however, the idea, good as it is, of saving printing and postage and not bothering the recipient with things that would not interest him, is partially vitiated by a very slight mistake on the sender's part, of fastening the sheets together by their upper edges, instead of along the left-hand edge. As a rule, bound catalogues which open vertically from the reader, are inconvenient to handle, and still more so to file; and when the collective catalogues are fastened together at the upper edges they are given both these most undesirable features. Fasten them at the left-hand edge; and where feasible perforate them so that the recipient will have no trouble in putting them in a folder or other binder.

R. G.

INTERNAL CUTTING TOOLS*—1

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON†

The conditions met with on the Brown & Sharpe automatic screw machines are such that for general work the simpler the design of the tool used, the more efficient will be the results obtained. Of course, in some cases it is necessary where difficult shapes are to be formed to make the tools somewhat complicated, but even then the simplest design possible should be adopted. It is obvious that in internal cutting there is more chance of the tool's sticking and breaking, due to the clogging of chips and improper lubrication, than on external work. It is therefore necessary to make all cutting tools for internal work with as much chip space as possible, and also to provide means for proper lubrication. The periphery clearance given to the tools also has an important bearing on their efficiency. Where there is too much cutting surface in contact with the work, the tendency is to produce rough work and also to break the tool, as heating is developed at the point of contact, thus causing the tool and work to seize.

In making complicated tools for internal work the excessive use of springs, especially when flat, is objectionable, for if the spring fails to work, the cutting tool is generally broken. If a spring is necessary, a coil spring should be

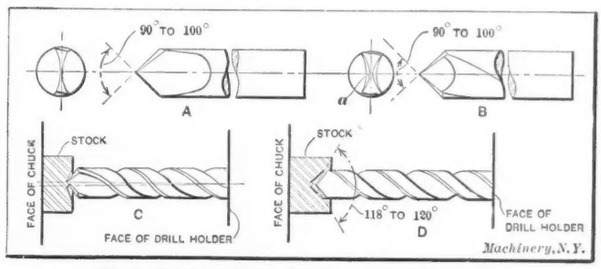


Fig. 1. Centering Tools—Starting the Drill Concentric

used and provision made to have it long enough so that it will retain, as much as possible, its initial tension. Springs for internal cutting tools, as well as other tools of a similar character, should always be tempered in oil, as this increases their life. The design of an internal cutting tool is largely governed by the material which it is to cut and the amount of material it is required to remove.

The tools used for internal cutting are numerous, but as one type of tool is generally better adapted for certain classes of work than another, the specific uses of the various tools and holders illustrated herewith will be briefly reviewed by the writer.

Centering and Centering Tools

When drilling holes which are less than 3/16 inch in diameter it is always advisable, especially when the hole passes through the work, to use a starting or centering tool. At *A* in Fig. 1 is shown a centering tool which is used for brass work, and at *B* is shown a centering tool which is used for steel and soft iron. This latter tool is made similar to the ordinary twist drill except that the flutes are shorter. A worn-out twist drill is sometimes used for this purpose and the point ground thin, as shown at *a*, which reduces the pressure and allows the drill to start easier. It also makes a better center than would a drill with a thicker point. The included angle of the cutting edges on a centering tool should be less than the drill which is to follow. If this is not the case the point of the drill will start to cut before the body of the drill is properly supported; consequently, an imperfect center will be formed. If an imperfect center has been formed, the drill will run out, as is shown clearly at *C* in Fig. 1. It can be seen that it is practically impossible for a drill to start concentric with the center of the work when a small

* For additional information on Brown & Sharpe automatic screw machine practice see "Designing Screw Machine Tools and Cams," MACHINERY, August, 1910, and other articles there referred to.

† Associate Editor of MACHINERY.

teat, as shown, has been left by the centering tool. Using a centering tool with a more acute angle obviates this trouble, as the body of the drill is well supported before the point of the drill starts to cut. This is also clearly shown at *D* in Fig. 1. The included point angle, which has been found most suitable for centering tools, varies from 90 to 100 degrees. 90 degrees should be used, preferably, for brass and 100 degrees for steel. The included point angle on the drill varies from 118 to 120 degrees, 118 degrees being generally used for the drill, as it has been found to give the best results.

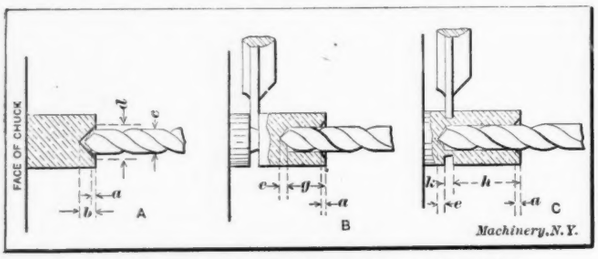


Fig. 2. Diagrams illustrating Method of Finding Cam Rise for Drilling and Centering

In Table I is given the length of the point for centering tools and twist drills, having included angles of 90 and 118 degrees, respectively. The formulas for finding the length of point for the various angles are as follows:

For 90 degrees $b = 0.5\ d$.
For 100 degrees $b = 0.43\ d$.
For 118 degrees $e = 0.3\ c$.
For 120 degrees $e = 0.29\ c$.
where b = depth of centered hole,
e = length of drill point,
d = diameter of centered hole,
c = diameter of drill.
(See Fig. 2.)

Cam Rise for Centering

When the length of the point on the centering tool is known, it is then an easy matter to find the rise on the cam required for centering. There are four different conditions governing the amount of rise required for centering, which are as follows:

First: When the drill does not pass through the work and a stop to gage the stock to length is used.
Second: When the drill passes through the work and a stop to gage the stock to length is used.
Third: When the drill does not pass through the work and a stop for gaging the stock to length is not used.
Fourth: When the drill passes through the work and a stop to gage the stock to length is not used.

The rises on the cam for centering as governed by the previous conditions are as follows:

First: $R = b + 0.010$ inch
Second: $R = b - e + 0.010$ inch
(See Fig. 2.)
where R = rise on cam for centering,
b = depth of centered hole,
e = length of point on drill.

It will be noted by using the second method that on starting a new rod the rise on the cam would not be sufficient to allow the centering tool to travel the full distance; or, in other words, would not be equal to the length of the point of the centering tool used. But the correct way to start a new bar is to throw over the operating lever, thus stopping the operating of the machine; open the chuck by hand and feed the stock out just past the cutting-off tool, enough to allow it to face off from 1/16 to 1/8 inch from the end of the bar. Then the stock is fed out by hand and the centering tool also operated by hand, after which the machine can be started.

Third: The rise for the various machines is as follows:
For the No. 00 $R = b + 0.020$ inch.
For the No. 0 $R = b + 0.028$ inch.
For the No. 2 $R = b + 0.035$ inch.

The values as given, which are added to b, are for facing, and the feeds should be decreased for this. A dwell should also be allowed on the cam varying from 2 to 5 revolutions, the number of revolutions necessary being governed by the material to be cut. More revolutions for dwelling are required for steel than for brass stock. The feed for facing brass should be from 0.0015 to 0.002 inch per revolution, and for steel the feed should vary from 0.001 to 0.0012 inch per revolution.

Fourth: The rise for the various machines is as follows:
For the No. 00 $R = b - e + 0.020$ inch.
For the No. 0 $R = b - e + 0.028$ inch.
For the No. 2 $R = b - e + 0.035$ inch.

As was previously mentioned, the feed should be decreased for facing, and from 2 to 5 revolutions for dwell left on the cam. The suggestions previously given should also be followed for starting a new bar. When short pieces are being made it is generally advisable to make the rise on the cam as given, as this sometimes saves from 5 to 10 minutes on each bar. This, as can be seen, will soon mount up when a large number of pieces are required. The time for starting a new bar in the manner given is practically negligible, as the machine always has to be stopped when a new bar is being inserted, or trouble will result.

Speeds and Feeds for Centering

The surface speeds for centering tools should be the same as for drills; the latter will be given under another heading. The feed for centering tools (as they are generally large enough to stand a heavy feed) is the same in most cases.

TABLE I. LENGTH OF POINT ON TWIST DRILLS AND CENTERING TOOLS

Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°	Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°	Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°	Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°	Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°
60	0.0400	0.020	0.012	41	0.0960	0.048	0.029	22	0.1570	0.079	0.047	3	0.2130	0.107	0.064	31/64	0.4844	0.242	0.145
59	0.0410	0.021	0.012	40	0.0980	0.049	0.029	21	0.1590	0.080	0.048	2	0.2210	0.111	0.067	1/2	0.5000	0.250	0.150
58	0.0420	0.021	0.013	39	0.0995	0.050	0.030	20	0.1610	0.081	0.048	1	0.2280	0.114	0.068	33/64	0.5156	0.258	0.155
57	0.0430	0.022	0.013	38	0.1015	0.051	0.030	19	0.1660	0.083	0.050	15/64	0.2344	0.117	0.070	17/32	0.5313	0.266	0.159
56	0.0465	0.023	0.014	37	0.1040	0.052	0.031	18	0.1695	0.085	0.051	1/4	0.2500	0.125	0.075	35/64	0.5469	0.273	0.164
55	0.0520	0.026	0.016	36	0.1065	0.054	0.032	17	0.1730	0.087	0.052	17/64	0.2656	0.133	0.080	9/16	0.5625	0.281	0.169
54	0.0550	0.028	0.017	35	0.1100	0.055	0.033	16	0.1770	0.089	0.053	9/64	0.2813	0.141	0.084	37/64	0.5781	0.289	0.173
53	0.0595	0.030	0.018	34	0.1110	0.056	0.033	15	0.1800	0.090	0.054	19/64	0.2969	0.148	0.089	19/32	0.5938	0.297	0.178
52	0.0635	0.032	0.019	33	0.1130	0.057	0.034	14	0.1820	0.091	0.055	5/16	0.3125	0.156	0.094	39/64	0.6094	0.305	0.183
51	0.0670	0.034	0.020	32	0.1160	0.058	0.035	13	0.1850	0.093	0.056	21/64	0.3281	0.164	0.098	5/8	0.6250	0.313	0.188
50	0.0700	0.035	0.021	31	0.1200	0.060	0.036	12	0.1890	0.095	0.057	11/32	0.3438	0.171	0.103	41/64	0.6406	0.320	0.192
49	0.0730	0.037	0.022	30	0.1285	0.065	0.039	11	0.1910	0.096	0.057	23/64	0.3594	0.180	0.108	21/32	0.6563	0.328	0.197
48	0.0760	0.038	0.023	29	0.1360	0.068	0.041	10	0.1935	0.097	0.058	3/8	0.3750	0.188	0.113	43/64	0.6719	0.336	0.202
47	0.0785	0.040	0.024	28	0.1405	0.070	0.042	9	0.1960	0.098	0.059	25/64	0.3906	0.195	0.117	11/16	0.6875	0.344	0.206
46	0.0810	0.041	0.024	27	0.1440	0.072	0.043	8	0.1990	0.100	0.060	13/32	0.4063	0.203	0.122	45/64	0.7188	0.359	0.216
45	0.0820	0.041	0.025	26	0.1470	0.074	0.044	7	0.2010	0.101	0.060	27/64	0.4219	0.211	0.127	3/4	0.7500	0.375	0.225
44	0.0860	0.043	0.026	25	0.1495	0.075	0.045	6	0.2040	0.102	0.061	7/16	0.4375	0.219	0.131	49/64	0.7813	0.391	0.234
43	0.0890	0.045	0.027	24	0.1520	0.076	0.046	5	0.2055	0.103	0.062	29/64	0.4531	0.227	0.136	13/16	0.8125	0.406	0.244
42	0.0935	0.047	0.028	23	0.1540	0.077	0.046	4	0.2090	0.105	0.063	15/32	0.4688	0.234	0.141	27/32	0.8438	0.422	0.253

Table II gives the feeds for centering tools having diameters as specified:

TABLE II. FEEDS FOR CENTERING TOOLS

Diameter in Inches	Feed in Inches per Revolution		
	Brass Rod	Machine Steel	Tool Steel
1/4	0.004	0.003	0.002
5/16	0.004	0.004	0.003
3/8	0.005	0.0045	0.004
1/2	0.0055	0.005	0.0045
3/4	0.006	0.005	0.005
1	0.0065	0.005	0.0055

The feeds as given are not extremely heavy, but it is obvious that if an imperfect center has been formed, disastrous results may occur. These feeds have been found satisfactory for general work.

Centering Tool Holders

The manner in which a centering tool is held when being applied to the work governs to a considerable extent the results obtained. The tool should be held rigidly and concentric with the center of the work if an imperfect center, as shown at *C* in Fig. 1 is to be avoided. At *A* in Fig. 3 is shown a common form of centering tool holder. This holder has been found very successful for general conditions when the work has been gaged to length by a stop, thus obviating the necessity of using a facing tool. It is supplied with a split bushing *a*, as shown in the end view, or is made without the bushing, the hole for the centering tool passing through the body and the shank, being the same diameter as the centering tool. In most cases the holder with the split bushing is preferable, as the tool is more easily set concentric with the center of the work. At *B* in Fig. 3 is shown a combination centering and facing tool holder. This holder is used when the stop for gaging the work to length has been dispensed with, the tool *b* being used for facing the work to the required length. This is found to be a very suitable holder where the work does not project more than 2½ times

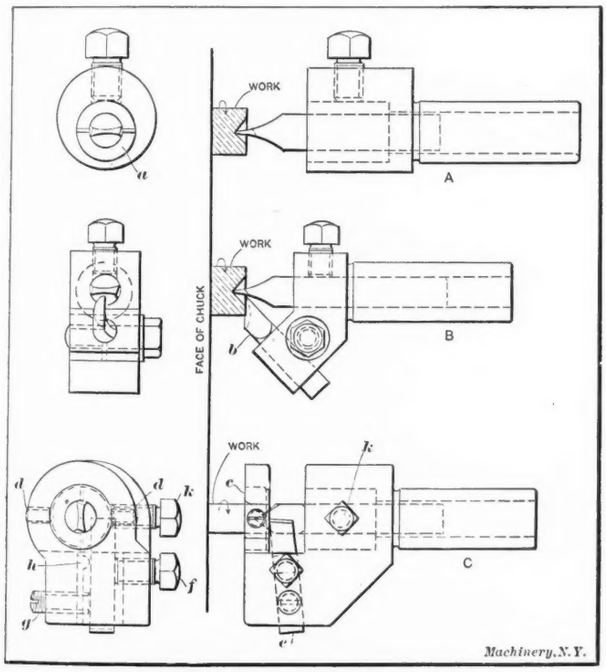


Fig. 3. Various Types of Centering Tool Holders

its diameter from the face of the chuck. At *C* in Fig. 3 is shown a combination centering and facing tool holder with a supporting bushing *c*, which is held in the body of the tool by two headless screws *d*, shown in the end view. The centering tool is held in a split bushing similar to that shown at *a* by set-screw *k*. The turning or facing tool *e* is adjusted to cut the required diameter by set-screw *f* and headless screw *g*, the block *h* acting as a fulcrum. This holder is used when the work has been turned before centering, and it is also found convenient for centering long and slender work. A B. & S. floating holder is sometimes used for holding the centering tool when the turret and spindle are not concentric.

Drills and Drilling

For general work commercial drills of the two-fluted type are used exclusively on the B. & S. automatic screw machines for drilling cylindrical holes. The spiral fluted drill is used for drilling machine steel, Norway iron, etc., and also for shallow holes in brass; but when deep holes are to be drilled in brass a straight fluted drill should be used in preference to a spiral drill, as it breaks up the chips, allowing them to be removed with greater ease. The grinding of the lips on the cutting edge of the drill, has a considerable bearing on the shape of the chips produced and also on the amount of power required to force the drill into the work. If the angle as previously given is used, and if the point of the twist drill is ground thin, it will produce a long, curling chip, and will not require much power for drilling. When drilling,

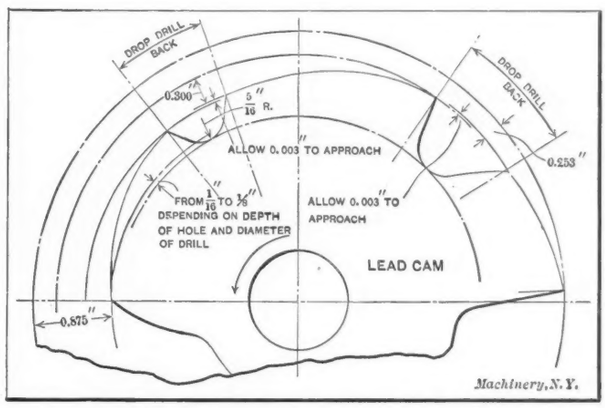


Fig. 4. Method of Laying out Cams for Deep-hole Drilling

if the edges of the drill burn, it is an indication that the surface speed is too high; if the drill chips, the feed is too great, and if the drill splits at the point it is an indication that the proper clearance has not been given at the cutting edges. The correct method of grinding twist drills was given in the June, 1909, number of MACHINERY. If the centering tool and drill have been ground to the correct included point angle there is no reason why the drill should not produce a straight and cylindrical hole; that is, if the feed is not increased too much.

Cam Rise for Drilling

There are three general conditions which govern the amount of rise required for drilling. They are as follows:

First: When the drill does not pass through the work and a centering tool is not used.

Second: When the drill does not pass through the work and a centering tool is used.

Third: When the drill passes through the work and a centering tool is used.

There is also another condition, *viz.*, when the drill passes through the work and a centering tool is not used; but as this is not a commendable method, the rise on the cam when drilling in this manner will not be given.

The rises on the cam for drilling as governed by the previous conditions are as follows:

First: $R = g + e + 0.010$ inch (see *B* in Fig. 2).
Second: $R = g - a + 0.010$ inch (see *B* in Fig. 2).
Third: $R = h + k - a + 0.010$ inch (see *C* in Fig. 2).

where R = rise on cam for drilling,
g = depth of hole to be drilled,
e = length of point on the drill (see Table I),
h = overall length of the work,
k = thickness of the cut-off tool,
a = distance that the drill projects in from the face of the work in the centered hole before starting to cut (see *A* in Fig. 2).

The values of a for centering tools having 90- and 100-degree point angles are as follows:

For 90 degrees, $a = d - c \times 0.5$ inch.
For 100 degrees, $a = d - c \times 0.43$ inch.
where d = diameter of centered hole,
c = diameter of drill.

It will be noted that k is the thickness of the cut-off tool.

Therefore, when tapping a hole which passes through the work the thickness of the tool should be greater than for ordinary work. This was explained in a previous article dealing with circular form and cut-off tools which appeared in the March, 1910, number of MACHINERY.

Deep Hole Drilling

The automatic screw machine lends itself to the production of straight holes, but when producing deep holes there are a number of difficulties to overcome, three of which are the following: In the first place, the drill is not at the will of the operator, and cannot be withdrawn from the work when it begins to seize or plug up with chips; in the second place, keeping the point of the drill cool and removing the objectionable chips is a difficult proposition, and, in the third

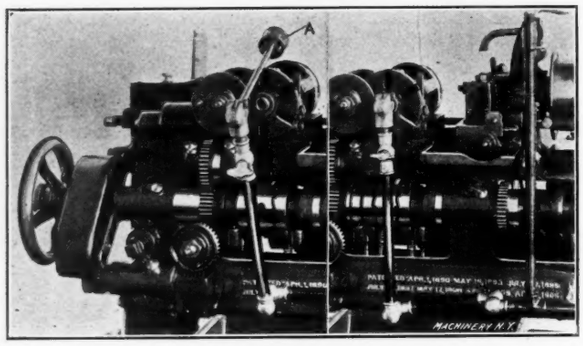


Fig. 5. No. 00 Brown & Sharpe Automatic Screw Machine equipped with Oil-pumping Attachment for Turret Tools

place, the feed of the drill is governed automatically. It is, therefore, necessary to take extra precautions to have the drill well lubricated and the feed not greater than it will stand.

More desirable results are obtained by giving a rotary motion to the work and a feeding motion to the drill for shallow holes, but when drilling deep holes the drill and the work should both be given a rotary motion. This helps to clear the chips from the holes and also allows oil to penetrate to the cutting point of the drill.

When drilling deep holes the drill should not penetrate into the work more than two and one-half times the diameter of the drill before being withdrawn from the work. For drilling deep holes in tool and machine steel, the spiral fluted drill is generally used with good results, but for drilling deep holes in brass the straight fluted drill gives better satisfaction, as it does not produce a long, curling chip, which is

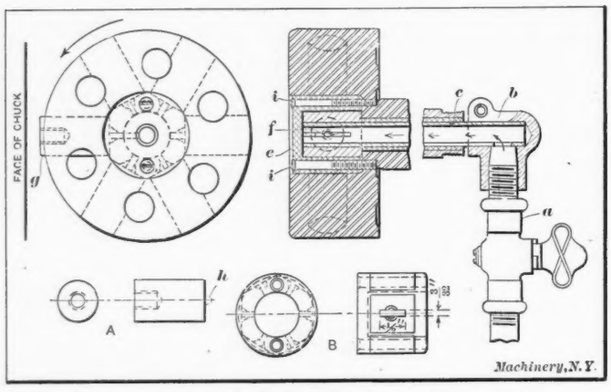


Fig. 6 Sectional View showing Construction of Oil-pumping Attachment for Turret Tools

generally objectionable. Further information on the subject of deep-hole drilling can be obtained from MACHINERY's Reference Series Pamphlet No. 25.

Designing Cams for Deep-hole Drilling

As was previously mentioned, the drill should be dropped back clear of the drilled hole, so that the chips can be removed from the flutes and the drill cooled and lubricated. To accomplish this the lead cam is laid out as shown in Fig. 4. To explain the method of laying out a cam for deep-hole drilling we will take a practical example: Assume that a hole ⅛ inch in diameter and ⅞ inch long is to be drilled in a piece of brass rod. Now, it can be seen that this will require three distinct lobes on the cam, as it will be necessary to drop the drill back twice in producing the hole. The rises for the various lobes can be found with the aid of the following formulas:

Rise on first lobe $= 2\frac{3}{4} \times D + 0.005$ inch.
Rise on second lobe $= 2\frac{3}{8} \times D + 0.003$ inch.
Rise on third lobe $= 2 \times D + 0.003$ inch.

where D = diameter of drill in inches.

The amount for each successive rise should be decreased in about the same proportion, and the feed on the drill should also be decreased slightly for each additional lobe when cutting machine and tool steel; but when cutting brass the feed can generally be uniform for each lobe. The rise on the various lobes would then be as follows:

Rise on first lobe $= 2\frac{3}{4} \times \frac{1}{8} + 0.005 = 0.349$ inch.
Rise on second lobe $= 2\frac{3}{8} \times \frac{1}{8} + 0.003 = 0.300$ inch.
Rise on third lobe $= 2 \times \frac{1}{8} + 0.003 = 0.253$ inch.

The depth to which the drill can be fed into the work before withdrawing can sometimes be increased, especially when a turret drilling attachment is used and the drill is greater than ⅛-inch in diameter.

The space on the cam surface necessary for dropping the drill back is generally equal to the space necessary for revolving the turret. It is, therefore, advisable to use more than one drill when there are sufficient empty holes in the turret, as it will not be necessary to resharpen the drill so frequently, and it will also be kept cooler.

Oil-pump Attachment for Turret Tools

When drilling and cutting deep holes, where a good supply

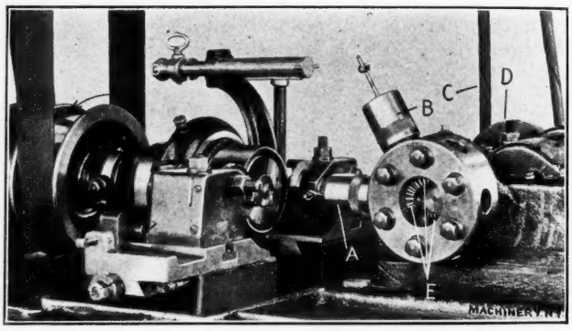


Fig. 7. No. 2 Brown & Sharpe Automatic Screw Machine equipped with Drilling Attachment

of oil to the cutting edge of the tool is necessary, the attachment A shown in Fig. 5 is used. To the right of the engraving the attachment is shown inserted in the turret, and to the left it is shown removed. To explain clearly how this attachment works we will refer to the line engraving, Fig. 6. The oil is brought through the pipe a, as shown, up into the tube c, which is held in the split elbow b. The pipe c passes through the bronze bearing in the turret spindle to the oiling attachment e. This pipe has a slot f 3/4 inch long by 3/32 inch wide cut in the end facing the chuck. It is, therefore, obvious that oil can flow from this pipe only through the tools which are facing the chuck and in operation on the work. If any of the holes in the turret are not in use, a plug is inserted as shown at g. A clearer view of this plug is shown at A. The small teat h is not necessary, but keeps the oil well within the attachment. The oiling attachment e is fastened to the turret by two small screws i. Thus the attachment rotates with the turret, bringing each hole successively into line with slot f, where the oil can flow through. The outer shell of this oiling attachment is shown at B. Slots 1/2 inch long by 3/32 inch wide are cut in the hexagonal surfaces as shown, allowing the oil to pass through. The idea of having these slots elongated is to provide oil to the tools where it is impossible to have the oil pass through the hole in the center of the tool. A hole can be drilled close to the outside of the shank, and passing through the body,

thus allowing the oil to penetrate to the cutting point of the tool.

Turret Drilling Attachment

In Fig. 7 is shown a No. 2 Brown & Sharpe automatic equipped with a turret-drilling attachment, two drill holders *A* and *B* being shown in position in the turret. This attachment is driven from the overhead works by the ½-inch twisted belt *C*, the shaft passing through the turret connecting the pulley *D* with the bevel gears *E*. The manner in which this attachment is located and held in the turret is clearly shown in the sectional view Fig. 8. The pulley *D* is keyed to the

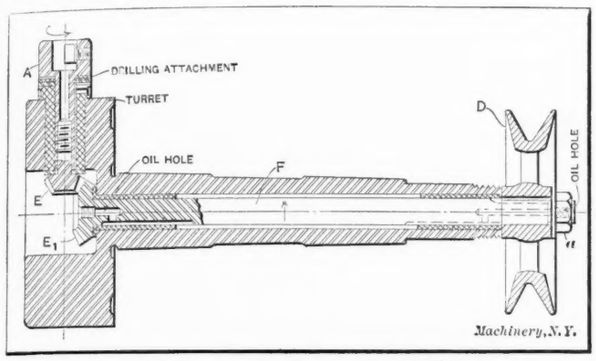


Fig. 8. Sectional View showing Construction of Drilling Attachment

shaft *F* and is also held in position with the nut *a*. Shaft *F* and bevel gear E_1 are made in one piece. The spindle of the drill holder is made of steel, hardened and ground, and runs in phosphor-bronze bearings.

The grooved pulley on the countershaft can be changed to increase or decrease the speed of the drill, as may be desired. The drill is revolved in the opposite direction to that in which the spindle and work are rotating, thus increasing the speed of the drill relative to the speed of the other tools. It is, therefore, obvious that the lobe on the cam for the drilling operation cannot be calculated from the speed of the spindle alone, but must also take into consideration the speed of the drilling attachment. To illustrate clearly the method of finding the number of revolutions required for drilling we will take a practical example. Before proceeding with the calcu-

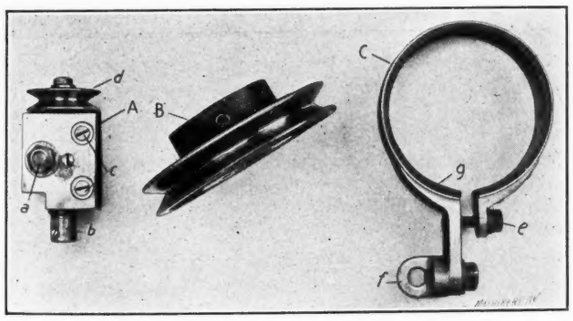


Fig. 9. Brown & Sharpe Cross-slide Drilling Attachment

lation we will assume the following values for speeds, depth of hole, time, etc.:

Let speed of spindle = 1200 R.P.M.,
speed of drilling attachment = 900 R.P.M.,
number of seconds to make one piece = 20,
total number of revolutions to complete one piece = 400,
depth of hole = ⅜ inch,
diameter of drill = ⅛ inch,
feed on drill = 0.0032 inch per revolution.

Then the total revolutions required for drilling, if the drilling attachment is not used, would be $= \frac{0.375}{0.0032} = 117$ revolutions.

Then, the actual number of revolutions required for drilling when using the drilling attachment $= \frac{1200}{1200 + 900} \times 117 =$ 66.85, or, approximately, 67 revolutions.

The following are three of the many advantages gained by using this attachment: First, the drill and the work are both given a rotary motion, which tends to produce a straighter hole than if the work alone were rotated; second, rotating the drill facilitates the removal of the chips from the hole and also allows the lubricant to penetrate to the cutting point; third, a suitable surface speed for the drill can be obtained without increasing the speed of the other tools in the turret.

It may also be mentioned that a spiral fluted drill gives satisfactory results for drilling machine steel and brass when using this attachment; but for drilling brass where a long, curling chip is objectionable, the lips of the twist drill can be ground in, making them similar to a flat drill.

Cross-slide Drilling Attachment

It is sometimes found necessary to drill holes in a piece of work, at right angles to the center line, or, in other words, across the piece. For this kind of work the cross-slide drilling attachment shown at *A* in Fig. 9 is found very serviceable. To apply this attachment to the cross-slide, the toolpost which carries the circular tool is removed and the attachment located in its place. The attachment is then held to the cross-slide by means of screw and nut *a*. The drill is held in a bushing in the spindle *b* by means of the headless screw shown. The two screws *c* are provided for taking up the wear in the bronze bearing. The small grooved pulley *d* is keyed to the spindle *b* and held by the nut and washer

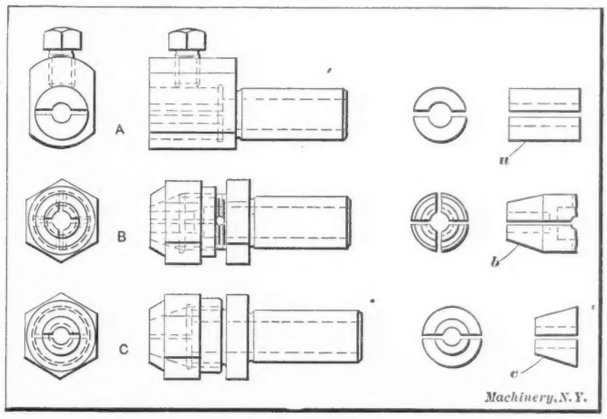


Fig. 10. Various Types of Drill Holders

shown. The large grooved pulley *B* is located on the countershaft and drives the cross-slide drilling attachment through the medium of a ⅜- or ½-inch round twisted belt, the size of the belt depending on the machine to which the attachment is to be fitted. In cross drilling it is necessary to stop the spindle and also hold it rigidly before the drill can operate. A brake shown at *C* for holding the spindle when drilling is used for this purpose. The brake proper is made from soft iron and has a strip of leather *g* attached to its inner surface, which grips the spindle firmly, preventing it from slipping. The cap-screw *e* is used for tightening the clamp on the pulley. The lug *f* is located on the pin which acts as a stop for the cross-slide tools. It is obvious that threading operations cannot be performed without the aid of a die and tap revolving attachment, as the spindle can rotate in one direction only. When using a revolving attachment in connection with the cross-drilling attachment, the threading attachment rotates the tap in the proper direction to release it from the work when the spindle is stopped, so that the tap is operated at one-half the spindle speed for running on the work and at the same speed for releasing from the work. For example, if a right-hand thread is being cut, the tap is rotated left-hand, advancing in the work when the spindle is running and retreating when the spindle is stopped. An opening die-holder is also sometimes used for cutting external threads when a cross-drilling attachment is used. The method of fitting up this attachment is as follows:

The belt is removed from the pulley nearest the collet, and the band *C* expanded over the pulley. It is then fastened to the pin which acts as a stop for the cross-slide, and clamped to the pulley by cap-screw *e*. The dogs on the

drum are then set to throw the clutch onto the pulley, which is clamped just before the drilling attachment advances toward the work. After the drilling operation has been completed and the drill retreats from the work, the clutch is thrown out and onto the other pulley and the other operations continued. The spindle is reversed practically instantaneously in both directions, but it is advisable to allow about five revolutions before and after the drilling operation for clearance. The drill should be ground with a more acute point angle than for ordinary work, and should also be ground thin at the point to facilitate its starting into the work. The rise on the cam is similar to the rise for ordinary drilling, but the feed should be less. In most cases, for cross-drilling operations it is an advantage to carry a guide bushing in the turret for locating the drill. Under this condition it is obvious that the work is drilled as if it were held in a jig, as the bushing is held in a floating holder that can be adjusted to produce the desired relation between the cross-hole and the outside diameter of the work.

Drill Holders

There are various types of drill holders used in the automatic screw machine, some of them being more complicated and expensive than is really necessary. The alignment of the turret holes with the spindle is nearly always perfect, and it is not necessary to have floating holders for holding a drill. At *A* in Fig. 10 is shown a common form of drill holder. This drill holder is serviceable and cheaply made. As can be seen, it is slabbed down on the sides to take up as little space as possible when working in conjunction with the cross-slide tools. The hole for the bushing is laid off eccentric to the main body of the holder, which allows enough stock on the upper portion to hold the set-screw. A plain bushing as shown at *a* is used. This bushing holds a drill very effectively. At *B* is shown a more expensive holder which is sometimes used for holding reamers and counterbores for operating on a piece which has previously been drilled concentric. This holder is made solid and then slotted as shown. The bushing part of the holder is shown at *b*. At *C* is shown a holder somewhat similar to that shown at *B*, but instead of the shank and drill holder being in one piece, a bushing is used. This holder is easier to set concentric with the work, but the extra cost prohibits its use to a great extent. The bushing as used in this holder is shown at *c*. For ordinary work the holder shown at *A* is advisable.

Drilling Speeds and Feeds

When drilling in the Brown & Sharpe automatics the best results are generally obtained by giving the drills light feeds and high peripheral velocities. The reason for this is that the conditions as obtained on the automatics are nearly ideal as regards lubrication and uniformity of feed. High-speed drills are commendable for drilling Norway iron, machine steel, tool steel, etc., but the ordinary carbon drills are suitable for brass and similar materials where the surface speed does not exceed that given in the following. The surface speeds here given for carbon and high-speed drills have been found satisfactory for the materials specified:

Speeds for Ordinary Carbon Drills

Material	Surface Speed in Feet per Minute
Brass (ordinary quality)	160—180
Gun screw iron	60— 70
Norway iron and machine steel	50— 60
Drill rod and tool steel	30— 40

Speeds for High-speed Drills

Material	Surface Speed in Feet per Minute
Gun screw iron	100—125
Norway iron and machine steel	80—100
Drill rod and tool steel	50— 60

Feeds for high-speed and ordinary carbon twist drills are given in Table III. The feeds given are for general work, but when the surface speed is not high the feed on the drill can be increased somewhat. It is found to be more satisfactory in general practice to keep the feed down, as a straighter hole can be produced than if the drill is forced.

Drills from 1/8 inch to 3/16 inch are capable of standing the heaviest feeds in proportion to their diameter, and where a hole does not pass through the work a 1/8-inch drill has been found to stand a feed of 0.016 inch per revolution when drilling brass. Feeds as heavy as this are not recommended, because concentric holes cannot be produced when the drill is forced to such an extent.

TABLE III. FEEDS FOR HIGH-SPEED AND CARBON TWIST-DRILLS

Diameter of Drill, Drill Gage or Inches	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Diameter of Drill, Drill Gage or Inches	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
70	0.00070	0.00060	0.00050	9/32	0.0058	0.0052	0.0042
65	0.00075	0.00065	0.00055	9/64	0.0059	0.0055	0.0043
60	0.00080	0.00070	0.00060	11/64	0.0060	0.0058	0.0045
56	0.00120	0.00100	0.00080	3/16	0.0062	0.0060	0.0048
1/16	0.00180	0.00150	0.00100	13/64	0.0065	0.0062	0.0050
5/64	0.00250	0.00200	0.00120	7/32	0.0068	0.0065	0.0052
3/32	0.00250	0.00230	0.00150	15/64	0.0070	0.0068	0.0055
7/64	0.00300	0.00250	0.00180	1/4	0.0070	0.0070	0.0058
1/8	0.00320	0.00280	0.00200	17/64	0.0072	0.0072	0.0059
9/64	0.00350	0.00300	0.00230	9/32	0.0075	0.0075	0.0060
5/32	0.00380	0.00320	0.00250	19/64	0.0078	0.0078	0.0062
11/64	0.00400	0.00350	0.00280	5/16	0.0080	0.0079	0.0063
3/16	0.00420	0.00400	0.00300	21/64	0.0082	0.0080	0.0064
13/64	0.00450	0.00420	0.00320	11/32	0.0085	0.0082	0.0065
7/32	0.00480	0.00450	0.00350	3/8	0.0090	0.0083	0.0068
15/64	0.00500	0.00480	0.00380	13/32	0.0095	0.0085	0.0069
1/4	0.00550	0.00500	0.00400	7/16	0.0100	0.0088	0.0070

* * *

The British firm of Vickers Sons & Maxim, Ltd., Barrow, England, has erected an interesting apparatus for testing propellers for aeroplanes and airships. The apparatus consists of a horizontal cantilever 165 feet long, mounted on a cast-iron pedestal. At the end of the cantilever is placed a 100 H. P. electric motor connected by gearing to a propeller shaft, which runs at velocities varying from 500 to 1000 revolutions per minute. Directly above the pedestal, a place is provided for taking the observations. The cantilever rests on a ball-bearing at the upper end of the pedestal. A velocity of 70 miles per hour can be obtained at the outside periphery of the cantilever. On account of the long radius of the circle in which the propeller is moving, the circular arc at every point coincides nearly with a straight line, so that the experiments made give practically the same results as if the propeller were used directly in an aeroplane or airship. Owing to the circular motion, the effect of the wind is neutralized, and a very accurate comparison between different kinds of propellers can thus be made.

* * *

An ingenious process of finishing high-speed gears has been proposed, its theory being that low spots in mating gears will be built up as the gears are run together. The method proposed is to electroplate the teeth with copper while running them in a suitable plating tank. The process is the direct opposite of the wearing-down process which, as every gear expert knows, is not conducive to the best results.

SOME FIXTURES USED IN MILLING PARTS OF LANDIS GRINDERS

By W. G. NEVIN*

In manufacturing parts of the Landis grinders to the extreme degree of accuracy required, many interesting fixtures are used to insure a high standard of workmanship and also to assist in rapid production. A few of the many fixtures used in producing parts of these machines are shown in the accompanying illustrations.

In Fig. 1 a milling fixture is shown that is used for holding the headstock base while the surface upon which the cover is secured is being finished. As the engraving shows, duplicate jigs are used, the operator filling one jig, while the other piece is being milled, thereby accomplishing what might be called continuous milling, with the exception of the time lost in moving the cutter from one piece to the other. In finishing the shoulder, the table is fed by hand against a positive stop, the power cross-feed being used in cutting. The work is mounted on a No. 4 Cincinnati high-power vertical machine. The cutter used is 6 inches in diameter and is preferable to one of a larger size, as there is less torsion. The way the work is held in this fixture and its construction is so plainly shown that a description is unnecessary.

In Fig. 2 another fixture or vertical milling operation is shown, the work being in this case a thin cover or spindle guard. As a raised pad around the edge of this cover had to be finished, it was necessary to design the fixture so that the work would be held rigidly, but without interfering with the movement of the cutter. The clamping is effected by set-

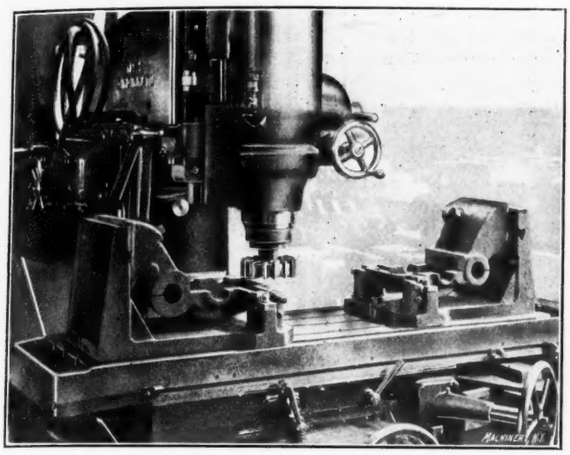


Fig. 1. Milling Fixture for Headstock Base

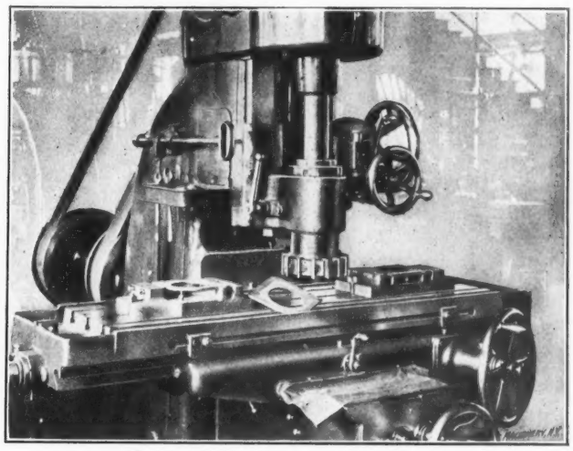


Fig. 2. Milling Fixture for Spindle Guard

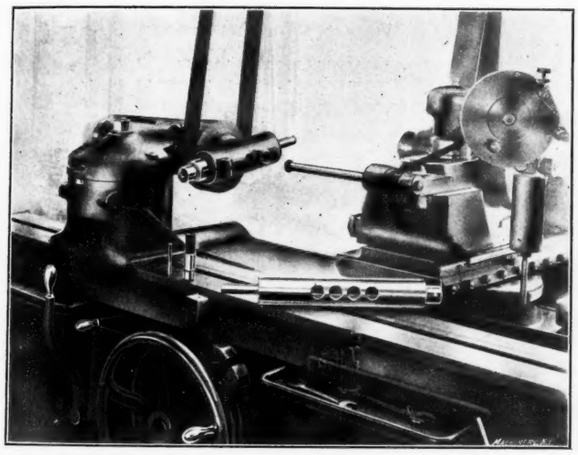


Fig. 3. Fixture for Grinding Clutch-pin Holes in Speed-change Shafts

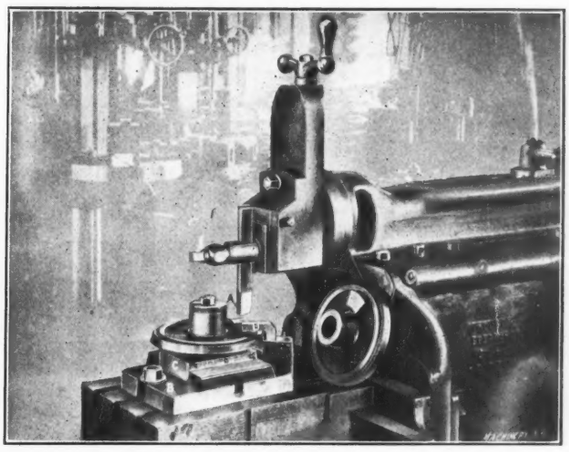


Fig. 4. Shaper Fixture

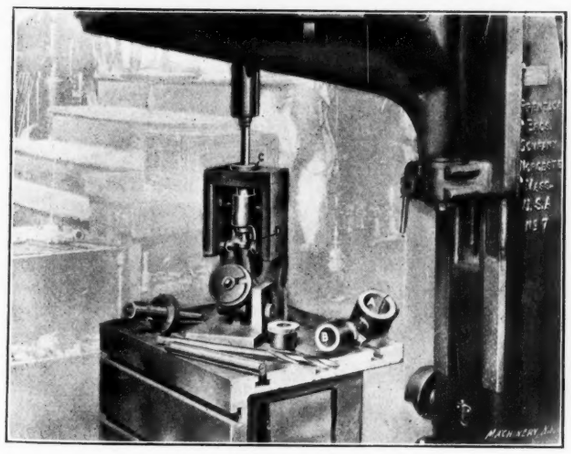


Fig. 5. Drilling and Boring Jig

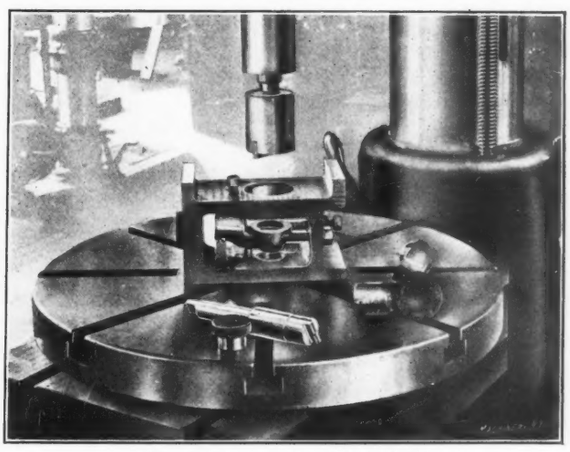


Fig. 6. Boring, Tapping and Facing Jig

* Address: 7 West North St., Waynesboro, Pa.

screws that force serrated jaws against the side cover, which is additionally supported against downward thrust by adjustable screws and the body of the fixture. The work is shown mounted on a No. 2 Brown & Sharpe vertical milling machine.

In Fig. 3 is shown an interesting fixture for grinding the holes for the clutch pins in the speed-change shafts for the headstocks. The fixture consists of a cast-iron head, having a spindle which runs in bearings of the universal headstock, with a pulley for driving and a sleeve for carrying the shaft to be ground, all being cast in one piece. After the first hole is ground, the shaft is loosened and shifted until the finished hole coincides with a hole in the sleeve in which a close-fitting plug is inserted, which insures the proper spacing of the holes.

The fixture shown in Fig. 4 is for shaping the sides of lugs on the backs of bevel gears. This fixture has a base *B*, on which is mounted a sub-plate *C*, that has a tongue piece which fits a cross-slot in the base. On each side of the sub-plate *C* there are pins which are spaced to allow the plate a cross movement equal to the width of the tool's cutting edge. When the fixture is first set up, the table is adjusted until the center of the gear is in line with the travel of one side or the other of the tool, depending on the position of the sub-plate. A square-nosed tool, ½ inch wide, is used and the sub-plate is first set so that the side *A* of the tool is in line with the center of the gear, that is with the plate moved against the

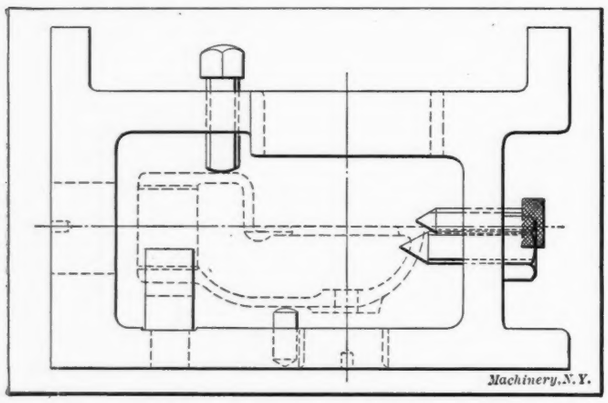


Fig. 7. Elevation of Jig shown in Fig. 6

stop pin on the farthest side, as viewed in the illustration. One side of the lug is then machined, after which the gear is loosened and the plate shifted against the opposite pin, the movement of the sub-plate equaling the width of the tool. The gear is turned until the planed face of the lug comes against the stop *D*, the other side of the tool being used for finishing the remaining side of the lug.

In Fig. 5 a drilling and boring jig is shown that is used for machining bevel pinion supports. After the hole *A* is bored and faced in a lathe, the remaining work is done in a jig. Hole *B* is first bored and reamed. Bushing *C* is then inserted in this hole and also through a line bushing in the jig with which it fits. The bar runs in bushing *C* while boring hole *D* and, as it is supported close to the hole, perfect alignment is assured. The remaining holes are then drilled, after which the job is complete.

In Fig. 6 is shown a boring, tapping and facing jig for pipe swivels. The work is supported and located at one end by a V-shaped block, and at the other by two conical-pointed screws as shown. In addition, there is a small pin beneath the center of the swivel and a set-screw at the top for clamping. A central knurled screw, which also has a conical point is brought into contact with the work, as illustrated in Fig. 7, during the boring and tapping operations, after which it is backed out so as not to interfere with the facing cutter, which is shown inserted in the spindle. All machine work is done without removing the piece and the facing bars run in steel-lined bushings which are hardened and ground. This method of using guiding bushings gives far better results than piloting the bars in a drilled or reamed hole in work being machined.

PRODUCTION OF "HEAT-BLACK" FINISH ON BRASS, BRONZE AND COPPER

The so-called "heat-black" finish on brass, copper, or bronze is one of the new methods of coloring metals that has recently appeared and is one of the most durable. It is adapted for a large variety of work and is even replacing nickel-plated work for some kinds of articles. Desk telephone sets are now being finished in the "heat-black," and in many parts of the United States have supplanted the nickel-plated article previously used.

The adaptability of the "heat-black" finish is wide, and the reader will undoubtedly find many new uses for it. The color is an absolute dead black, and as it is not difficult to apply, the future will undoubtedly find it extensively employed. It can be applied to brass, bronze or copper. It does not work evenly on steel or iron.

The article to be treated should be free from grease, although a slight tarnish does no harm. It is usually customary to sand blast the surface, although very good results may be produced without it. A sand-blasted surface takes an excellent finish, but those who do not possess the apparatus for producing it need not have any hesitation in using the finish without it, as about the only difference between the results is that the sand-blasted surface is a little more dead.

The Solutions

Two stock solutions are first made up. One is a solution of nitrate of copper in water, and the other is a solution of nitrate of silver in water. The proportions need not be exact, although it is preferable to keep them fairly close. They are made up as follows:

Nitrate of Copper Solution

Water	1 oz.
Nitrate of copper	1 oz.

This gives a practically saturated solution of nitrate of copper in water and is used for a "stock" solution. If desired, the nitrate of copper may easily be made by taking 1 ounce of strong nitric acid and dissolving in it all the copper wire it will take up. A thick, blue solution is left which is used for the "stock" solution. As few platers have nitrate of copper in stock, it can easily be made from the copper wire.

Nitrate of Silver Solution

Water	1 oz.
Nitrate of silver	1 oz.

This solution can also be made by dissolving pure silver in nitric acid until no more will dissolve, but dilute acid (1 part acid and 1 part of water) should be used as silver does not dissolve readily in strong nitric acid. It is preferable, however, to purchase the nitrate of silver as it is easily obtained. The nitrate of silver solution is practically a saturated solution and is used as the "stock" solution.

Mixed Solution for Applying

The mixed solution for applying to the metal is made as follows:

Water	3 parts
Nitrate of copper solution	2 parts
Nitrate of silver solution	1 part

The solution is kept in a glass or stone-ware vessel for use.

Applying to Brass or Other Metals

The brass, bronze or copper article to be treated is heated on a hot iron plate or in an oven to a temperature of about 250 degrees F. and the solution applied with a brush or cotton swab so as to cover the surface uniformly. The brush should be a rather soft one in order to allow the coating to be made in the best manner. The so-called "rubber-set" brushes are the best for the purpose, as there is no metal on them to be attacked by the solution.

One or two coatings of the solution on the surface of the article is usually enough; it dries almost immediately leaving a green froth. The temperature is not sufficiently high to draw the temper of hard brass, but it will usually melt soft solder.

When the entire surface has changed to a uniform black color, allow the article to cool and then brush off the fluffy

material on the surface of the metal with a stiff-bristled brush. The color will now change to a brownish-black that is quite pleasing for many purposes and which is very tenacious. When the fluffy material is completely brushed off, it is surprising how even and uniform the coating is and how tenaciously it adheres. If the brown-black finish is desired, the surface may now be waxed or lacquered, but it is usually customary to give the article an additional treatment in a liver of sulphur solution in order to change the brown-black coating to one that is absolutely dead black.

Final Treatment

When the smut has been brushed off from the surface of the article, it is immersed in a cold liver of sulphur solution for 5 minutes. This solution is made by dissolving 2 ounces of liver of sulphur in 1 gallon of water. The article is immersed in it, allowed to remain about 5 minutes and then, without rinsing, is again heated until the surface is uniformly black.

The surface is now brushed again with the bristle brush when it will be found that the color is a dead black and quite uniform. It should be borne in mind that the article is not rinsed at all after it is removed from the liver of sulphur solution, but is simply drained off and then heated.

The article may now be lacquered with a flat lacquer or waxed as may be desired. The final appearance of the surface will be found quite satisfactory and contrary to what one would naturally expect. The coating of the solution that is first applied need not be very even as long as a sufficient quantity is put on.

The process as arranged by steps may be summed up as follows:

1. Applying the solution to the metal.
2. Heating on a hot plate or oven until the solution has dried and the residue left by evaporation has turned black.
3. Brushing off the smut.
4. Immersion for about 5 minutes in a liver of sulphur solution.
5. Drying without rinsing and heating on the plate or in the oven again.
6. Lacquering or waxing.

If the surface is not satisfactory, or an old article is to be refinished, the wax or lacquer may be burned off and the process repeated.

It is believed that this is one of the most satisfactory black finishes known, as it is dead black, is readily applied and is very durable. It is calculated to resist considerable handling, such as a desk telephone would receive. There are many articles that can well be treated by it.—*Brass World.*

* * *

INCREASING PROFITS BY REDUCING COSTS VS. INCREASING PRICES

"There are two ways only of increasing profits," said Mr. H. L. Gantt to the National Association of Cotton Manufacturers at its annual meeting in April; "one by increasing the selling price, the other by reducing the cost of production. The successful salesman, or the operator who has succeeded in persuading his competitors to join with him in upholding or advancing prices, has, on account of the increased profits resulting from his efforts, been considered a very important man, and been compensated accordingly. The recognition of ability and the compensation for success in this field have been so great that capable workers from all directions have swarmed into it, and the industry of making prices has prospered amazingly. With increase of prices comes higher cost of living; with higher cost of living comes demand for higher wages; with higher wages comes higher cost of production. Then, to maintain the same profit under the new conditions, we must again increase our selling price, and the cycle repeats itself. This process has been going on for years, and as the producers have gradually been attracted from the field of making products to the more lucrative one of making prices, to-day we have a surplus of prices and a shortage of products. The field has been overworked."

* * *

An alloy of 95 per cent of copper and 5 per cent of aluminum is the nearest imitation of pure gold of any of the known alloys.

CARE OF MACHINERY

By H. M. WOOD*

The majority of machine tool users—including even the large shops—fail to realize how absolutely essential are all details in the care of their machinery if their work calls for any degree of accuracy.

The foundation is a very important adjunct to any machine. Money spent to secure a firm and unyielding base is true economy. A machine should always be leveled up when first installed, and care should be taken that the wedging material used to bring it level will not warp or shrink. A carpenter's level will not do for setting machinery; this work requires a sensitive level of known accuracy.

Occasionally we receive a complaint: "Lathe just received will not turn true; send operator." In such cases we almost invariably find the difficulty results from a shaky foundation from the lathe being out of level. As soon as the machine is leveled up so that the bed lies perfectly horizontal, the alignment is just as perfect as when the machine was shipped. Many managers don't see how a heavy casting can spring out of true by being a bit out of level. But it is an established fact that no matter how massive the bed, or what the style of the machine, it must be level to do its best work. A planer has an extremely massive bed—in fact, the bed constitutes the bulk of the machine—and it is truly surprising how "warped" planer work will be if the bed is out of level.

No matter how good the foundation, a machine cannot be leveled "once for all." Our product requires the most accurate machine work. Therefore, we have a shop rule that on the first Saturday afternoon of each month every foreman must stay (the plant closes at noon on Saturday) and personally see that each machine in his department is absolutely level.

Cleanliness is another essential; manufacturers more generally recognize that this is so—as applied to the other man's factory. The accuracy of the work turned out by any machine tool depends upon the alignment of the different parts and the regularity of their relative movements. If chips cover the ways of a lathe and work in under the carriage bearings, the quality of the work will rapidly depreciate and the machine itself will soon need to be overhauled. A little grit will play havoc with the spindle bearings. A dirty chuck plate will soon spoil the threads of the spindle nose. Yet in many plants expensive machines, capable of accurate work when properly cared for, are subjected to these abuses.

We expect each operator to care for his own machine to the extent of keeping all bearing surfaces free from dirt and chips. Laborers empty the chip pans beneath the machines as frequently as necessary. In addition to this, there is a general clean-up once a week. Each department has one or two men who thoroughly clean all machines every Saturday afternoon and wipe up the bearing surfaces with oily rags.

With the heavy duty put upon machines by present-day high-speed cutting tools, ample lubrication is more necessary now than it ever was. Not only are the speeds higher today, but there are also greatly increased pressures on the bearings, due to deeper cuts. The oiling of the line-shafting and countershafts can well be left in charge of one man in every department, but each operator must be largely depended upon to oil his own machine as frequently as necessary.

We find that sight-feed oil cups, each holding a day's supply of oil, are a great advantage on the main bearings. In the first place, they insure positive lubrication of the journals and allow the supply of oil to be exactly regulated to suit individual conditions. Another valuable feature of the sight-feed oil cup is that the glass shows at a glance whether the cup is full or empty. The superintendent in passing through his shop can instantly tell whether or not the oiling has been attended to. A full oil cup proves that that particular bearing has been recently oiled, and is also a pretty good indication that the operator did not forget to oil the other bearings when he had his oil can in hand.

Careful attention to the leveling, cleaning and oiling will increase the life of the machine and a better grade of work will be turned out. Many costly delays will also be prevented, because the machine is not out of commission for repairs.

* Address: Care of Lodge & Shipley Machine Tool Co., Cincinnati.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

The sixteenth yearly volume of MACHINERY was completed with the August number. The index for the Engineering Shop and Railway editions is ready for distribution, and will be sent to any address on receipt of request. A new form of index has been compiled in which the page numbers for all three editions appear in parallel columns, thus really combining three indexes into one. The advantage of the new form is that all the matter published in the three editions is shown in one index. The total number of reading pages in the Engineering and Railway editions, exclusive of forty-eight data sheets and thirty-six shop operation sheets, is 1042.

* * *

BAD PRACTICE IN THE USE OF UNIVERSAL JOINTS

A fundamental principle is so often violated in the erection of the common universal or Hooke joint that it seems worth while to call general attention to the bad practice which results in irregular action and reflects on the intelligence of the mechanics in charge.

When two universal joints are used to connect shafts at a right angle or less, the knuckles should be so located that the pins in the knuckles of the middle shaft are parallel. Very often they are placed in some other relation, often in planes at a right angle.

The reason for requiring the parallel positions of the pins or axes is, of course, to preserve uniformity of angular motion throughout a revolution. The variation of angular velocity is as $\cos a$ to $\frac{1}{\cos a}$ in one joint, but if two joints are connected with their knuckle pin axes parallel, the irregular action of one joint is offset by that of the other, thus making the motion transmitted to the driven shaft practically uniform.

Machine designers should thoroughly appreciate the necessity of preserving uniformity of angular motion wherever possible, especially in rapidly turning shafts. Mysterious breakdowns have been traced to improperly placed universal joints. When so placed that the knuckle axes are at an angle, the variable action of one joint is superimposed upon that of the other, resulting in irregularity of action in the ratio $\cos^2 a$ to $\frac{1}{\cos^2 a}$ when the pins are at right angles. To show the difference in action take the case of a shaft connected to another at an angle of 60 degrees through an intermediate shaft and two universal joints, each working through an angle of 30 degrees. When properly connected, the driven shaft rotates uniformly with the driver, the intermediate shaft varying in the ratio first given. If the driver runs at 100 revolutions per minute, the intermediate shaft action varies at the rate of 86.6 to 115.4 turns per minute. Now if the knuckle-joint pins are at right angles the irregularity of action of the intermediate shaft is transmitted to the driven shaft in increased ratio, being, in the case given, in the ratio of 75 to 133.3 turns per minute. Imagine the severe torsional stresses imposed on the shafts and joints when running at high speed and driving wheels or gears of considerable weight.

* * *

THE MODERN CONCEPTION OF BUSINESS

The old saying, "business is business," with its implication that success in trade and commerce is founded merely on shrewd business dealings and one-sided bargains is happily being replaced by the broader conception of business relations defined by the expression "service for service." It is coming to be more and more universally understood that the bargain must be mutually advantageous in order to be really beneficial to either party. The truth of this has made itself more keenly felt in some industries than in others, and the machine building industry in general was one of the first to recognize its economic value. The machine builder cannot be satisfied with a mere *sale;* to him it is of the greatest importance that his machine makes good for the particular purpose for which it is sold. The salesman who sacrifices all other considerations to the one of merely making a sale will not long be a useful factor in the success of his firm. For permanent success it would be better sometimes to make no sale at all, than to sell a machine not suited to the buyer's requirements. The most successful firms are those which thoroughly inquire into the needs of the purchaser and then carefully select the machine most suitable. In such a case both buyer and seller are benefited by the transaction. Future trade relations are likely to be on a basis of mutual confidence; and firms which handle their customers with this in mind will acquire a reputation for reliability. It is a case of service for service. The seller receives a fair price and makes a reasonable profit, and the buyer obtains a machine by means of which he is able to perform the work in his shop or factory to better advantage.

The same principle of service for service makes the relationship between employer and employe one of mutual confidence instead of one of misunderstanding and strife. The employer who requires good service also expects to pay a fair price for it, and the employe who expects fair compensation for his services should give a full day's work in return; but whenever either tries to secure a price or service out of real proportion to value given or received, then the "service for service" idea has been lost sight of, and the door is opened for suspicion, misunderstanding and antagonism which ultimately work a loss to both parties. The "service for service" idea is the modern principle of business, and while its full application is, perhaps, not possible without thorough-going social reforms in many directions, it is the ideal toward which every permanently successful business must strive.

* * *

"The micrometer," says a well-known instructor in machine shop practice, to his classes, "is essentially a measuring instrument of precision, but in order to be an instrument of precision in the hands of the unaccustomed, it must be used with extreme care. Especially is it an instrument that must be used carefully and slowly by the beginner: First, to obtain accurate adjustment and second, to read the measurement correctly. With careless adjustment or incorrect reading, or both, the micrometer is anything but an instrument of precision; on the contrary its use may cause more mistakes than the use of ordinary calipers."

THE COST OF ACCIDENTS IN THE INDUSTRIES

We have already discussed in MACHINERY the basis and justification for employers' liability laws, and have given some figures* relating to the cost to employers of their enforcement. Laws of this character have been adopted by all industrial countries except the United States,† and are intended to make the industry in which an accident occurs bear the financial responsibility for it. The objection most commonly made to employers' liability laws is that the heavy expense would have to be met by the employer, and that in many competitive enterprises the margin of profit is so narrow that there is nothing with which to finance an expense burden of this kind if enforced by a rigid liability law. In connection with the statistical information given in the December, 1907, number of MACHINERY, some information published by the *Engineer*, London, in reviewing the recent workings of the liability laws of Great Britain, may be of interest.

According to the figures published in that journal, the average annual compensation per injury per employe at work in the metal trades is $1.52; or at the rate of hardly more than one-half cent per working day. Of course, this figure would be somewhat higher in the United States, owing to the generally higher level of prices and the consequent higher rate of compensation required; but on the same basis as the British liability laws one cent a day per employe should cover the employer's expense for this insurance, the casualty companies assuming the burden of paying compensation in cases of proved liability, up to the amounts of the policies issued by them. The experience of England seems to indicate that insurance against disability due to accidents in the industries would by no means involve a serious burden on the employer.

A very important result of the workings of the new liability law in England is that instead of going into court with their differences, as was formerly nearly always customary, these are now usually adjusted and the compensation settled directly between the parties concerned, according to the law, and without the expense of litigation.

* * *

THE UTILITY OF THE ENGINEERING PROFESSOR

By JULIAN C. SMALLWOOD‡

There are two charges that may be brought against the engineering professor. First, he is not, in the economic sense, a direct producer; second, he does not satisfy the special need which is supposed to justify his existence. To amplify, the old-fashioned idea about the school teacher is that he is a man worthy of some respect as knowing more than his fellows. This respect, however, is tempered with a certain amount of condescension because he cannot or does not apply his learning in the practical world. He can only impart knowledge; he cannot use it. He can develop others so that they may make money, but he cannot make it himself. Now, this idea about teachers in general still prevails, and it still clings to the technical teacher. It may be that it is more marked in his case than in others. Engineering, of all professions, is most directly concerned with economics—in the last analysis with the dollar. Therefore, it is natural that the popular eye should be attracted to the discrepancy between the engineering professor's vocation and profession. It is reasonable, too, to conclude that if he cannot apply his knowledge to engineering production he cannot adequately teach others to do so. These two shortcomings, whether wholly or partly true in the individual case, are attributed to a quality of mind too abstract, too theoretic, too narrowly academic. The scientific professor is pictured by those who hold these views as a man whose nose is immersed in a book and whose vision is limited by the margin of the printed page, a man whose wisdom comes from texts and not from the life and work-a-day world around him.

It is well that the practical engineer of to-day, the manufacturer, and the father of embryonic engineers should ascertain the worth and limitations of the engineering teacher. In a large sense all those who are concerned with engineering enterprise are directly concerned with the utility of the technical professor. It is he who prepares and shapes the brains of future organizations and, in a measure, with his university, guarantees their fitness. We may therefore ask: "Is he a practical engineer to the extent that he could make a living in his profession or not, and can he in either case teach engineering?" It is the purpose of this article to answer the two divisions of this question.

There are two classes of engineering professsors—those who practice their profession and teach it and those who do not practice it. The former class has an unquestioned utility in engineering production, the latter may or may not have it, and members from either class may or may not be able to teach. It is thought that if a man knows his business thoroughly and has made a success of it he can impart to others his wisdom and ability. This idea is clearly a superficial one; nevertheless, there are universities which accede to it to the extent of employing men as teacners whose reputations as successful business men are big with no other apparent reason than that their names look well in the catalogue. It is a bowing to popular clamor, and in this commercial and competitive age, when universities sprout—mushroom-like—over night, many such bows must needs be made. So these gentlemen adorn the catalogue and undoubtedly draw customers. "Professor Blank," reasons the manufacturer who is about to send his son to college, "knows all about power-plant practice and now he is going to teach it at Dash University. That is the place for my son. It employs practical men." Professor Blank, however, may be a fool in the class- or lecture-room or in any room outside the power house.

Whether or not the professor is directly engaged in engineering production aside from his teaching, his utility in the latter may be judged almost infallibly by what he has or has not written. A good teacher can hardly refrain from writing a book, and if any teacher is the author of a textbook which fulfills its purpose well and thoroughly, it is an almost certain inference that he is capable in the class-room. It is not an absolutely certain inference, for a man may be able to write clearly and yet be unable to formulate his thoughts quickly enough for clear speech. The important qualification, however, is that he be able to *think* clearly; if he writes so, it is certain that this is the case, and therefore likely that he can transmit his thoughts orally, as well.

This brings me to a consideration decidedly favorable to the engineering professor who is engaged only in academic work. The standard textbooks, and, in fact, the greater and more valuable part of technical literature, are contributed by him. This affords a chance for education through his agency not only to those who come into personal contact with him, but to many others who have neither the time nor the money for a college course. Such works are used not only by students, but by practical men who find it necessary to add some theory to their knowledge. Furthermore, the particular kind of technical literature that the academic man produces probably would not be created at all but for his efforts. The work written by the so-called "practical engineer" is vastly different from professorial contributions. The latter may be thought too theoretical, but, on the other hand, it should be noted that this very excess of theory is what the practical man needs to round out his education and usefulness. His daily experience teaches him practicality; it does not teach him the theory of practice.

In the field of research and invention the technical teacher has been unquestionably useful. Little research for the general good is accomplished by others. Almost the only others engaged in such work are certain business organizations which do so only for the furtherance or their own ends and generally do not publish their results. In invention, of course, the professor does not preempt the field; nevertheless, it is remarkable how much of this sort of production is attributable to him. Consult almost any reference or textbook and you will find many devices invented by academic men for the furtherance of scientific measurement and in-

* See MACHINERY, November and December, 1907, engineering edition, "Liability of Employers."

† A new liability law was enacted by the last New York State Legislature, going into effect September 1, which provides for compulsory compensation to employes for accidents sustained in dangerous work, no matter who is at fault. The new law marks a great step in advance in the relation of employers and employes, and undoubtedly will result in greatly reducing accidents in hazardous occupations.

‡ Address: Chadwick, N. J.

vestigation, as well as practical machinery and constructions. In this way and in research they have furnished the guide posts by whose aid much of our rapid advance along the road of engineering science has been accomplished.

In the foregoing I have pointed out unquestionable services performed by the men who make it their business to teach. Undoubtedly there are many of them who do not share in these services; who are satisfied to remain in the rut made by timeworn lectures and repetitions of class-room grinds. But surely the accomplishments of the former, even though they are in the minority, are sufficient to remove the stigma of incapability in practical work attached to them as a class.

In regard to the usefulness of the professor in the class- or lecture-room, it has been previously mentioned in this article that, no matter what his practical attainments are, it does not follow that he is an efficient educator. If he is a practicing engineer he is better equipped to teach his profession, and there can be no doubt that there are many such who do so. Aside from this, if his individuality is strong and he possesses what is called "personal magnetism," his influence in education may be tremendous simply through the force of his personality. He excites the admiration of his students who seek to emulate him. His words are eagerly listened to and his slightest statement may be remembered for years. It may be that he is not a profound scholar nor imparts words of wisdom to be obtained nowhere else, but that what he says is convincing and sinks in. Probably every college graduate has been under one such man whom he well remembers and still admires as a "big" man, and equally probably there was only one.

Lecture courses given by such a teacher are of vast value not only in the training in engineering, but in character. Lecture courses given by any other than this sort of man are futile. They shift the work of learning from the student to the instructor, and they do it ineffectually if the latter has not the personality to rivet the interest of those whom he addresses. The process is like pouring water into vessels; some will be leaky and others will retain it all, but even such will never give out more than was poured in. The true function of education is to increase capacity; surely capacity is not increased by making students mere recorders of facts. In this part of the average professor's work I have no hesitation in saying that he does not adequately accomplish his purpose. Fortunately, however, it is not the only part. Education is imparted through recitations and laboratory work, the chief virtue of which is the mental training of the student involved in answering questions put to him by his instructor—questions not involving memory, but reason. The process of lecturing is like sowing seeds; the class-room work, like gathering the harvest. True, the seeds must be sown, but if the student does this himself and tills his own soil he will be better able to harvest. It is then the instructor's duty to see that the proper seeds are selected and to train their growth.

The question of whether a non-practitioner in engineering can teach his profession adequately is a serious one, for it is such that do most of the teaching in our technical schools. In this connection it may be remarked that a point overlooked by many critics of academic methods is that teaching is as distinct a profession as is engineering. To teach well requires study toward that particular object and practice in doing it. The ability to teach well is a gift of nature not easily to be acquired. Combine this gift with scientific attainments and a practical mentality in one man and you have the ideal engineering professor. Naturally, we may expect to find few such men, but this does not mean that the rest do not fulfill a useful function. The ideal opera singer is one who not only can sing, but can also act, and who combines these abilities with an admirable face and figure; yet those who are not in this way ideal are to be appreciated. They may lack the other qualities so long as they can sing, and in the same way the professor may lack the other qualities so long as he can teach. If he does lack them, at the worst he performs his functions in a mechanical way and grinds out a product year by year that has some, if not superior, merit. The result of his work, then, compares with what he might have produced, as machine-made art compares with handicraft. But I do not hesitate to say that the non-practitioner can do vastly better than this; that he can give engineering training of a high order to his students in the same way that astronomers can enlighten us upon the composition of the stars without ever having been on them.

It must be admitted, however, that the non-practitioner lives under narrowing influences which can be nothing if not detrimental to his university work. As a rule, he is interested in but one division of one branch of engineering and ignores the rest. He fails to take the broad view of the correlations of subjects, accentuates the trivial, and magnifies the theoretical. His theory departs too far from practice. He forgets that there is a line beyond which it is waste of time to carry theory. The result is that he does not teach adequately and may teach badly.

We may conclude, then, that the engineering professor's chief limitation is his estrangement from the practical world. To remedy this, those who are practical workers may in their own interest very materially assist. The business man and the scientist should recognize when each may supplement the other's knowledge and in doing so exchange benefits. In the laboratories of our technical schools there are splendid equipments for the determination of data for the need of which many a manufacturer is floundering helplessly. Such equipments are not maintained at their maximum usefulness when they are operated only in the performance of cut-and-dried experiments. Here we have the manufacturer developing a piece of machinery by unmethodically trying first one alteration and then another to ascertain the best combination, when at his elbow are the facilities for doing this work precisely and quickly and with advantage to those who undertake it for him. If the practical engineer makes his needs known to the technical educator and enlists his help, it will go a long way toward reducing the narrowing tendency of the latter's vocation and heightening his usefulness, as well. The technical schools should be open to and soliciting practical work, tests and research for the benefit of professors and students. There should be felt none of the old antagonism between theory and practice; where theory and practice do not agree it should be considered that it is not because the theory is false, but simply that it is incomplete.

On his part, the professor should seek to know the practical engineer, find out what he is doing, and, whenever possible, obtain work from him. He should remember that no amount of study of the practical side of his profession exactly fills the place of experience in it. The average teacher has plenty of time for such experience; he should seek it and aim to build up a practice for himself.

In concluding, I wish only to show as an example of ideal operation the methods of modern medical schools. Through their hospitals they furnish experience to their students and service to others. Their teachers are mostly men who practice their profession. Just so should the technical school be conducted—a service to those in need of scientific help, practical association for its students, and a training for its professors; in short, a hospital for the needs of engineering.

* * *

The following formula for determining the weight of flywheels for rolling mills is given in *Comptes Rendus Hebdomodaires*:

$$W = \frac{\text{H.P.} \times t \times C}{V^2}$$

in which W = the weight of the flywheel in tons of 2000 pounds,

H.P. = brake horsepower,

t = time in seconds between each pass,

V = the highest permissible velocity of flywheel rim in feet per second, and

C = a constant depending upon the permissible percentage of decrease in speed.

The constant C for a 5 per cent decrease in speed equals 185.3; for 10 per cent, 93.8; for 15 per cent, 65; for 20 per cent, 49.8; for 25 per cent, 41.3; and for 30 per cent, 35.3.

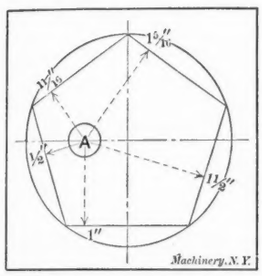
For cast iron, the velocity of the flywheel rim should not exceed 130 feet per second.

CLAMPS AND STRAPS FOR HOLDING WORK WHILE MACHINING*

By H. E. WOOD†

Among the tools used in the ordinary machine shop, the clamps and straps for holding work to the faceplate of lathes and the tables of drill presses, milling machines, planers, shapers, slotters, etc., play an important part. Not only is it necessary that the work is held down properly while the cut upon it is taken, but in any economically managed shop the required clamps and straps, clamping bolts, nuts, wrenches, etc., should be within easy reach of the machinist. It should not be necessary for him to search all over the shop in order to find suitable clamping appliances, but these should be kept in the tool-room or in some other convenient place where each man could easily find what he required for the particular job in hand. It is also well to adopt some standard designs of clamps, as this will often facilitate matters considerably.

In the Taylor system of shop management proper attention is given to the question of suitable clamping arrangements, as it has been found that often as much time is consumed in trying to find the required clamping bolts and straps as is necessary for the actual machining work. One of the principal objects of the Taylor system of shop management, as is well known, is to eliminate all useless waste of time and concentrate the workman's time and attention on the actual work in hand, this saving a large amount of time usually spent in preliminary preparations and unnecessary movements or operations. In the accompanying Data Sheet Supplement are shown a great variety of clamps and straps representing fundamental types. It is, of course, not necessary that a full set of all these types should be provided in the machine shop, but it is certain that it would be economical in the long run if each machine shop provided a set of sizes of the more common types for general use.



Laying out Pentagon for Adjustable Block Clamping Straps

Most of these clamps require little or no explanation. In Figs. 1 and 2 are shown clamps of the hair-pin type which are made either of square stock or of stock the width of which is two or three times the thickness. The latter clamp, of course, is used when a heavier stress will be put upon it. In Fig. 3 is shown a so-called "crotch-strap," which is used principally on drill presses. It is made in the same manner as the hair-pin clamp in Fig. 1, except that the end is opened up so that it straddles the hole to be drilled. In Fig. 4 is shown a closed-end strap which is also made of square stock; it differs from the clamp shown in Fig. 1 only in that both ends are joined as indicated. Fig. 5 shows a yoke strap which is used almost exclusively on lathe faceplate work. It is made of square stock and closed at both ends as shown.

Fig. 6 shows a clamp made of flat stock. This is perhaps one of the most common and simplest forms of clamps or straps. Holes are drilled at certain intervals in which the clamping bolts can be inserted. A strap of this kind can either have a bolt in the center and clamp work on each side, or it may be provided with blocking, and clamp work on one end only. The work can also be placed in the center of the strap and a bolt applied at each end. Fig. 7 shows a clamp of flat stock which embodies some improvements over that in Fig. 6. It is provided with a slot for the bolt, and with V-grooves at one end to suit certain classes of work. In Fig. 8 is shown a very useful type of clamp which can be removed without unscrewing the clamping nuts. It is extensively used where studs are set into the body of a jig or fixture. It is a time-saving device and should be used wherever suitable. Fig. 9 is a so-called teat-clamp with a slot for the clamping bolt. The round end may be used in a groove or in a hole drilled in the end of the work. Fig. 10 is a clamp of the same type except that the pin is inserted in the body, making a simpler and cheaper construction.

Where the space is limited, so-called finger straps are often used. One strap of this type is shown in Fig. 11. In Fig. 12 is shown a clamp of the same type, but reinforced so that a heavy clamping pressure may be applied to it. This strap can be used in places where no other strap would be applicable. In many cases it is advantageous to have straps which bear only on three points in order to insure a perfect bearing and clamping action. In Fig. 13 is shown such a strap. It is sometimes drilled and tapped at the end opposite where the two clamping points are placed, so as to permit of inserting a screw to be used as blocking. This arrangement makes the clamp adjustable for work of different heights. Fig. 14 shows a foot strap. This type is simple and efficient and is very commonly used. In Fig. 15 is shown a strap of similar construction, except that it is made so as to provide for a three-point bearing. The projecting end is round so that it will bear in the center only, and two heels are provided at the front end, one on each side to bear on the work being clamped. In Fig. 16 is shown a clamp of the same type as that in Fig. 14, with the exception that it is provided with the adjustable "foot" as indicated.

In Fig. 17 is shown a clamp having a quick adjustable blocking providing for five sizes of blocks. The clamp proper is pivoted to a block of steel shaped like a regular pentagon. Assume, for example, that the diameter of the circumscribed circle is 2½ inches. Then the block can be laid out as shown in the accompanying engraving. The left portion of the horizontal line from the center of the circumscribed circle to the point where this line intersects the side of the pentagon is divided into two equal parts; the point of division *A* is the center of the rivet passing through the block and the clamp. From point *A* draw a line perpendicular to each side of the pentagon. By doing this we find that we have five heights of blocking of the following dimensions: 1/2, 11/16, 1, 1 5/16, and 1 1/2 inch. It will be readily seen that this simple clamping device is a handy tool to have around the planer, milling machine, or shaper. A number of different sizes of these clamps may be provided covering a range of from say 3/8 inch for the lowest blocking up to 3 or 4 inches by very small intervals. A clamp constructed on this principle was patented some years ago. Whether or not the construction shown in the illustration and in the Data Sheet Supplement is an infringement on this patent is a matter which would be difficult to decide.

Figs. 18, 19 and 20 show straps of the well-known goose-neck type. The one shown in Fig. 18 is a single goose-neck strap, and the one shown in Fig. 20 a double goose-neck strap, used principally when clamping work in gangs on the planer table. The strap shown in Fig. 19 is known as a goose-neck teat-strap, having a round pin inserted which enters into a hole or groove in the work.

Fig. 21 shows a curved end strap for round work. The appliance shown in Fig. 22 is termed a clamp-strap, and is used for clamping round work, as indicated. Two of these straps can be bolted together and used as a lathe dog. In Fig. 23 is shown a "hump-back" strap which is also especially intended for clamping round work. In Fig. 24 are shown two straps used together for clamping work to a jig or an angle plate. In many cases this simple method provides an excellent clamping arrangement.

Most mechanics, of course, are familiar with all or nearly all of the types illustrated, but nevertheless it is believed that the logical grouping of these straps in the manner shown in the accompanying Data Sheet Supplement will prove of value to many, as it indicates the fundamental and most common forms of straps used in the machine shop, and suggests the improvements that may be made in standardizing equipment of this kind and keeping it in the stock-room or other central place for the use of the machinist, instead of having all kinds of straps scattered around the machine shop which can never be found when required, and which have been made without any particular aim of universal application in view, and therefore seldom can be properly applied to more than the special jobs for which they have been made.

* With Data Sheet Supplement.

† Address: 182 North 4th St., Newark, N. J.

THE AEROPLANE INDUSTRY IN FRANCE

By W. F. BRADLEY*

Within twelve months the construction of aeroplanes has developed in France from an auxiliary of the automobile and other trades to the dignity of an independent industry. France has shown so much activity and has had so much faith in the future of the aeroplane that it is the first country to raise aeroplane construction to the rank of an industry. Contrary to general supposition, it was not the automobile trade that gave birth to the aeroplane business, for when such men as Voisin, Ferber, Bleriot, Santos-Dumont and Levavasseur were experimenting with flying machines, the automobile manufacturers were so wrapped up in the possibilities of their own industry that they had not a thought for the insignificant rival which has forged ahead so rapidly. On account of this

Fig. 1. Assembling Engines at the Gnome Factory

lack of interest on the part of established manufacturers, the experimenters had to build machines in private shops, appealing to the coach-builder and the metal-worker for such fittings as could be advantageously employed for flying machines. The automobile manufacturers were not even willing to study the problem of light-weight motors, and it was not until Levavasseur—who had never been a motor car constructor—had produced a special light-weight engine, that flights were made possible in France.

The Voisin Brothers, Billancourt, opened an experimental shop primarily for the benefit of Ernest Archdeacon; they were willing, however, to work under the directions of any would-be flier who came along, and at the same time were quietly developing what they thought would prove to be a successful flying machine. Bleriot was sufficiently wealthy to maintain a private workshop. Santos-Dumont also made his machine in a small private shop. Levavasseur, together with his associates, built experimental aeroplanes with very little hope of securing a quick financial return.

Although at the present time only one firm is producing a complete aeroplane, at least half a dozen concerns are making the entire flying machine with the exception of the motor and the propeller. The Antoinette company is entirely independent of outside help except for the canvas covering used for the wings. Levavasseur, the engineer of the company, experimented with aeroplanes until he could make no further progress for want of a light motor. Then for about two years he worked at motors only, and when a satisfactory one had been developed, returned to the construction of aeroplanes, with the advantage of being independent of external aid.

The Voisin Brothers have built a number of complete machines carrying their own motors, but their usual plan is to build the aeroplane only and fit it with a motor selected by the customer. It appears likely that for the next few years there will be two distinct industries, one occupied with aeroplane building and the other with the production of special aeroplane motors. It is in this way that most of the present aeroplanes are produced. Bleriot, Henry Farman, Sommer, Hanriot, and Voisin all have important establishments devoted exclusively to the building of aeroplanes in lots, the motors for which are supplied by different manufacturers. These firms employ altogether about 600 workmen, but this figure by no means represents the number of persons engaged in the aeroplane industry, for there are not less than a score of shops partly employed on aeroplane construction and a number of aeroplane builders who are really assemblers, wings, fuselages, chassis and motors being built in different shops and brought to them to be put together.

Throughout France there are at the present time probably not less than 3000 workmen directly employed in the construction of aeroplanes, aeroplane motors and fittings. Antoinette has 100 to 150 men building and testing aeroplanes and motors. The Gnome factory has not less than 200 men in the aeroplane motor section; the Anzani shop has 100 men building aeroplane motors exclusively; the E. N. V. and Dutheil-Chalmers have about fifty each, and the Esnault-Pelterie has about the same number occupied in experimental work of different sorts. Propeller makers, boat builders, coach builders, and woodworkers in general who supply various parts for aeroplanes number fully 800. At least half the leading automobile manufacturers have devoted some attention to light-weight motors, employing altogether about 600 men in such work.

As a rule, French automobile manufacturers have been content to supply motors only, the number including such leading firms as Panhard, Renault, Darracq, and Mors. In only one case has an automobile manufacturer added aeroplanes to his catalogue, the enterprising firm being the Clement-Bayard company, Maisons Laffitte, Paris, builders of the Santos-Dumont type of flyer. As the entire framework is of steel tubing, it is possible for this company to build everything in its own shops with the exception of the detachable portions of the

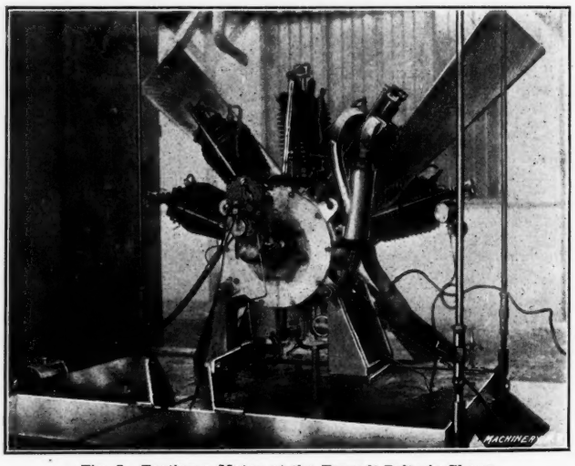


Fig. 2. Testing a Motor at the Esnault-Pelterie Shops

wings. As this is closely related to automobile body work, however, it is easy to foresee that as the demand for flying machines increases, the company will produce aeroplanes entirely under one roof, and in large lots, as is now done with motor cars. The Clement-Bayard company has also entered into the construction of dirigible balloons, obtaining the gas bags and cordage from specialists, but making the nacelle, or under framework, building and fitting the motors, and assembling and testing the whole.

The greatest success in light-weight motor construction has been made by comparatively small firms that previously built engines for special purposes. This is the case with the Gnome company, which formerly produced only heavy stationary motors, boat engines, and a few motors for car assemblers. Within twelve months the section of the factory devoted to the construction of light-weight revolving motors has become more important than the older branches and now employs 200 men who produce four or five aeroplane motors a day. Another example is the Anzani factory, which two years ago kept a score of men busy on motorcycle motors only; these have

* Address: Box 27, Times Square Station, New York City.

Fig. 3. Hanriot Testing Ground at Rheims

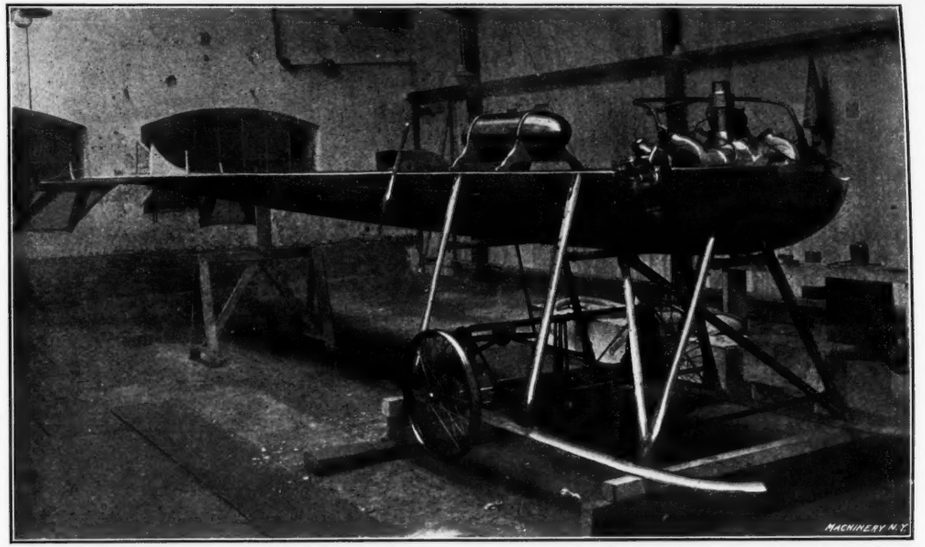


Fig. 4. Assembling an Aeroplane at the Hanriot Factory at Rheims

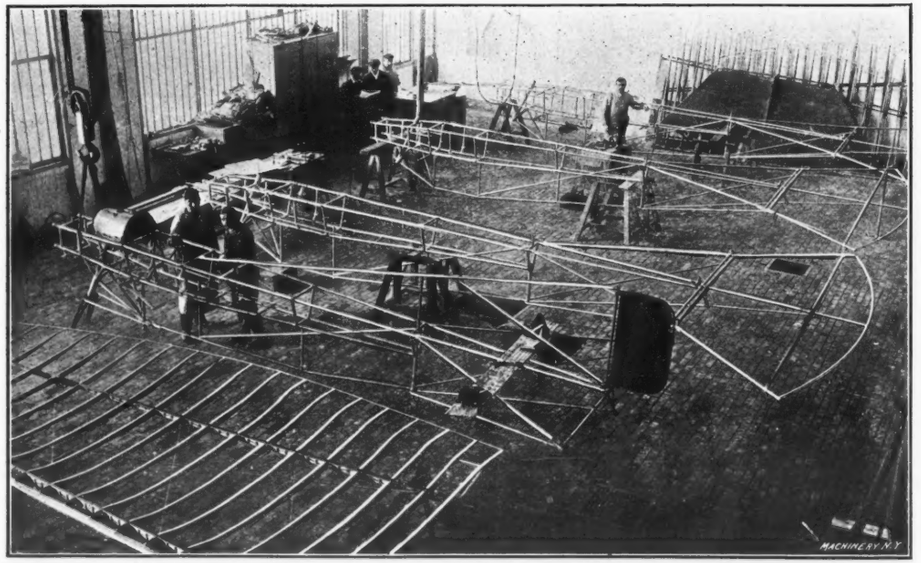


Fig. 5. Aeroplane Building at the Esnault-Pelterie Shops at Buc, France

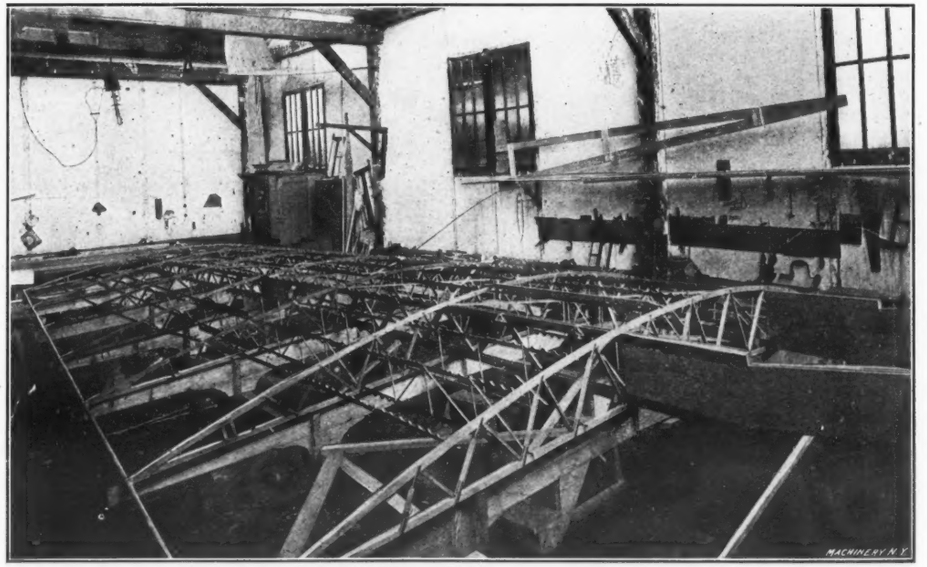


Fig. 6. Building Monoplanes—Societe Antoinette, 28 Rue des Bas-Rogers, Puteaux (Seine) France

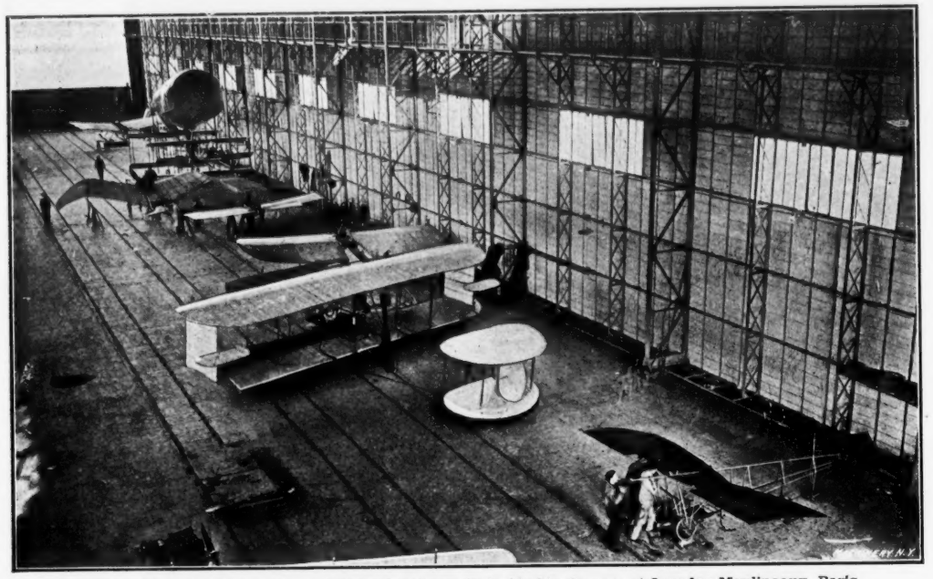


Fig. 7. View inside the Clement-Bayard Balloon Co.'s Airship Garage at Issy les Moulineaux, Paris

Fig. 8. Inside View of the Gnome Factory, 49 Rue Lafitte, Paris

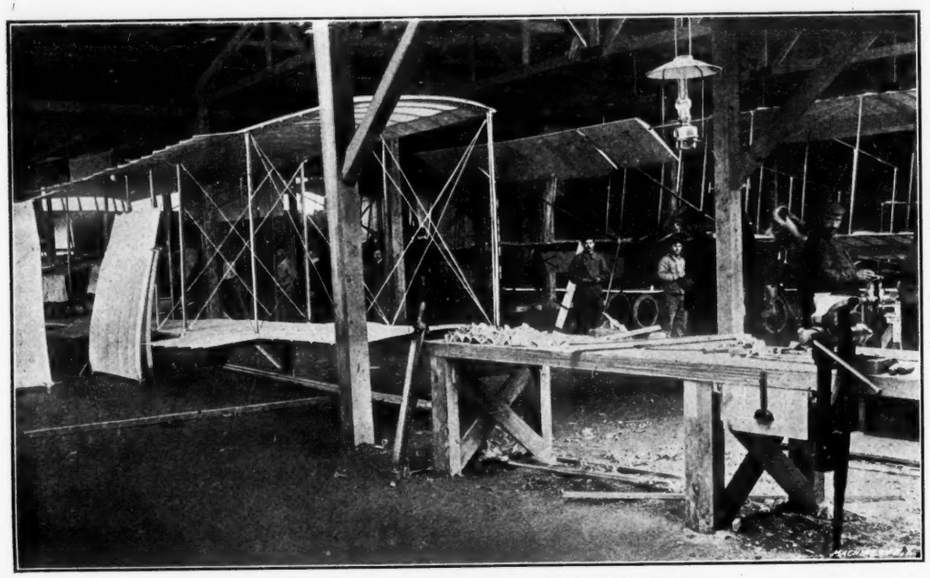


Fig. 9. View in the Henry Farman Shops at Mourmelon

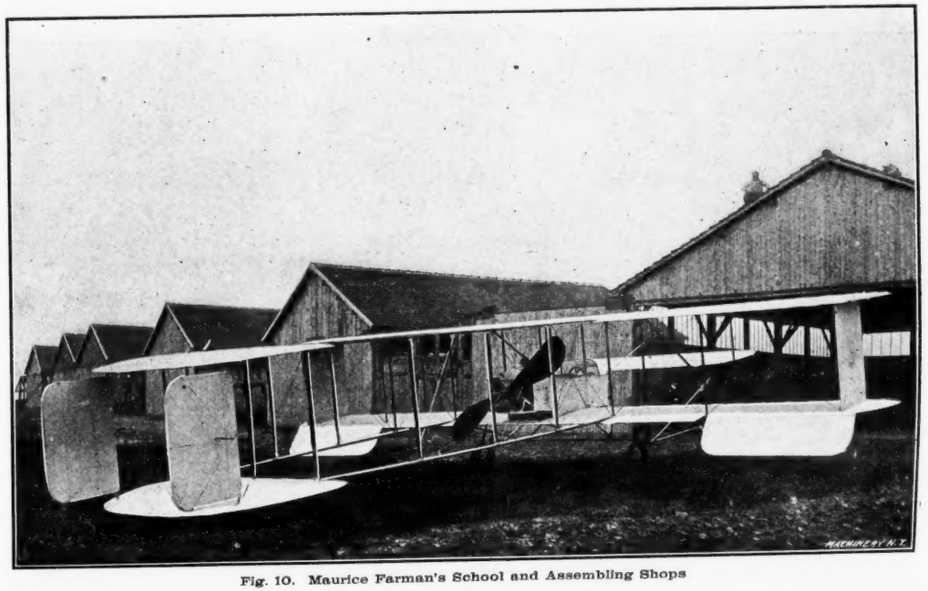


Fig. 10. Maurice Farman's School and Assembling Shops

now become auxiliary to the aeronautical section. The same conditions exist at the Dutheil-Chalmers factory, where aviation motors are built side by side with stationary gas engines and are beginning to exceed the latter in importance.

A certain number of men are also employed at the various aviation schools located in different parts of France. These include fitters, testers, repairmen and helpers, and although they are at present a rather small factor, the brisk sale of flying machines is a guarantee that their number will be considerably increased in the near future.

Until the aeroplane has become a more standardized article, and until a greater degree of efficiency has been attained in motors, it is likely that aeroplane building and the manufacture of special motors will remain separate industries. It is certain, however, that automobile constructors are only waiting for further developments to step into the aeroplane business, believing that it will be easier for them, with their engine experience, to copy a good type of aeroplane than it will be for the aviator to build special motors for his flying machines. This would be possible, however, only upon the supposition of some important discovery solving such a problem as automatic stability. If, on the other hand, the further development of the aeroplane is of the same slow and painful order as that of the past, it is likely that the present school of practical aviators will be able to keep the business in their own hands. The large motor car concerns will hesitate to invest their capital in aeroplanes until the period of groping has been brought to a close.

* * *

A GLOSSARY OF AERONAUTICAL TERMS

By L. R. W. ALLISON*

adjusting plane: A small surface for regulating lateral balance, usually located at the outermost end of a wing.

advancing edge: The front or leading edge of a supporting or balancing surface.

advancing surface: The anterior surface of a flying machine having more than one supporting plane.

aerocurve: A curved surface of a supporting plane; sometimes used to mean the amount of camber.

aerodrome: A mechanism similar to the aeroplane, and used in substitute; a course for flying machines. (Use is usually confined to latter term.)

aerodromics: The art of flying in the air with a heavier-than-air machine.

aerofoil: Used as a substitute for "aeroplane."

aeronate: A balloon that is fastened to the earth, *i. e.*, a captive balloon.

aeronaut: One who navigates the air.

aeronautics: The branch of aerostatics which treats of air navigation.

aeronef: Any type of heavier-than-air machine.

aeroplane: A dynamic machine. Name now given to any heavier-than-air machine with diversified form of supporting planes, but essentially applicable only to flat surfaces.

aerostat: A balloon free to move in air.

aerostation: The raising and supporting of balloons and flying-machines in air.

aileron: A small movable plane or wing tip usually hinged to the main planes and which can be operated independently. Used for maintaining lateral stability.

air shipping: Air craft of all kinds.

air speed: Rate of air flight.

airman: One who navigates the air; an aeronaut.

airmanship: Ability to navigate the air.

alighting gear: Controlling mechanism used in descending to stop the machine as it reaches the ground and diminish the jar.

angle of attitude: The angle formed by the main planes with the line of travel. Also called "angle of incidence"; "angle of inclination."

angle of entry: The angle formed by a tangent to the advancing edge and the line of motion in entrance to flight of aeroplane surfaces.

angle of trail: The angle formed by a tangent to the rear edge and the line of motion in entrance to flight of aeroplane surfaces.

apteroid: That form of wing which is short and broad.

arch: The downward curve or droop to the ends of supporting surfaces.

* Address: 1353 West 30th St., Los Angeles, Cal.

aspect: Plan view.

aspect ratio: The ratio of the length to the width of a wing surface.

aspiration: The suction of an air current against the edge of a curved aeroplane surface.

automatic stability: Stability that is maintained irrespective of any operating control—the self-action of the controlling surfaces in suiting themselves to flight.

aviation: Motion through the air by heavier-than-air machines.

aviator: The operator of a heavier-than-air machine.

balance: Maintaining equilibrium by proper movement of balancing surfaces.

balancing plane: Surfaces for establishing and maintaining equilibrium and to assist in turning, either automatically- or self-controlled.

Baldwin's patent cloth: A rubberized silk fabric, light in texture, used for covering aeroplane surface and balloons.

balloon: A "lighter-than-air" vehicle, properly applicable to gas bags with passenger baskets. The air currents and the raising power of the gas are the sole means of ascension.

beat: The periodic recurrence of flapping-wing or rotating-blade motion.

biplane: An aeroplane with two main supporting surfaces, one above the other..

body: The portion of the machine which contains the power plant, fuel tank and aviator's seat.

box-kite: Also referred to as Hargrave (from inventor). Used with reference to a box-like form, consisting of two vertical and two horizontal planes for lateral and longitudinal stability.

brace: Usually a compression member in the framework.

camber: The depth of curvature.

caster-wheel: A pivoted wheel in the alighting gear; placed forward of its center of rotation, it suits itself to the course of the machine.

cellular: Cell-like; sometimes used instead of "box-kite."

cellular tail: The extreme rear planes of box-kite form.

center-of-pressure or "center-of-lift": An imaginary center line on the under side of an aeroplane surface on each side of which the pressure is equal.

center-of-resistance: The center at which the different forward pressures balance.

center-of-thrust: The axis along which the thrust of the propeller or propellers is in equilibrium.

chassis: Supporting truck used on the ground.

compound control: A controlling system whereby two separate operations are executed by a double movement of a single device.

compression-side: The side of a surface which faces the flow of air current.

continental rubber cloth: Cotton material upon which a gum preparation is used. Used for aeroplane surfaces.

control-for-elevation: Rudder planes placed in front or in the rear of main surfaces. Sometimes in both positions.

deck: A main supporting surface.

diagonal: A diagonal brace in a framework.

dihedral angle: The angle formed by two planes.

dirigible: A steerable balloon, controlled and propelled by mechanism.

double-decker: An aeroplane with two main planes; a biplane.

double monoplane: A monoplane with two supporting surfaces in the same plane, one in front of the other.

double rudder: A rudder having two surfaces acting simultaneously.

double surfaced: Covering both sides of aeroplane surfaces.

down wind: Moving with the wind.

elevator: A horizontal rudder for vertical steering.

entry: an aeroplane surface moving in air, embracing the entire form.

equilibrator: Horizontal tail.

even keel: Preserving balance and position.

feathering: Surfaces maneuvered in a manner to pass edgewise and flatwise in alternate directions while in motion.

fin: A fixed vertical plane.

fish-shape: A section resembling in shape the body of a fish; commonly used in struts.

fixed wheel: A wheel which cannot move from its rotating plane.

flapping flight: Flight by up and down movement of wing surfaces.

flexible propeller: Propeller consisting of cloth mounted on a frame, adjusting itself to flight.

flying angle (same as flying attitude): The variation in the angle of an aeroplane surface in flight and at rest.

following edge: The rear edge of an aeroplane surface.

following surface: A supporting surface behind another.

forced pressure: Increase in air pressure due to direct action upon it.

fore-and-aft: Longitudinally.

front control; front rudder: Framework and planes situated at the extreme front of the aeroplane, in advance of the operator.

fuselage: The framework of an aeroplane.

gap: The vertical distance between two planes.

glide: To travel rapidly by deflecting an aeroplane surface at an angle; when close to the earth a tip upward allows the machine to settle with slight jar. This is done without power.

glider: An aeroplane without mechanical power.

glider shape: A truss form of construction.

gliding angle: The angle of "glide."

ground incidence: The difference in the angle formed by the aeroplane surface when on the ground and when in flight.

guide planes: Planes placed between the rudder planes.

hangar: A structure for housing aeroplanes.

head area: The total head resistance offered by the entire framework of an aeroplane.

head resistance: The resistance a surface offers to movement through the air.

helicopeter: A heavier-than-air machine in which flight is secured by propellers rotating in horizontal planes.

horizontal rudder: A horizontal plane in front of main supporting surfaces for vertical steering.

in-lap: Toward the starting point.

keel: The under framing of an aeroplane, to stiffen it both laterally and vertically.

land speed: The rate of travel of an aeroplane on the ground before ascension.

landing area: A special allotment of ground on which a machine can land safely.

lateral: A strut for sidewise bracing in the framework of an aeroplane.

lateral stability: Lateral equilibrium in the side-to-side direction.

leeway: Lateral drift in the direction in which the air current is flowing.

lift: The supporting effect of an aeroplane surface.

longitudinal stability: Lengthwise stability.

main landing wheels: The wheels which take the greatest strain in landing.

main plane: The largest supporting wing; in a multiplane the lowest surface.

mast: A strut for fastening trussing wires to stiffen the wings.

monoplane: An aeroplane with one or more supporting surfaces, all in the same plane.

monorail: A rail used as a track in starting a certain type of machine.

montgolfier: A hot-air balloon.

multiplane: An aeroplane with three or more main supporting surfaces; a polyplane or a triplane.

nacelle: The framework of a dirigible, sometimes used for framework of an aeroplane.

negative incidence: The angle of attitude below the line of travel.

non-rigid dirigible: A dirigible having no rigid framework for the gas bag.

ornithopeter: A machine which attains flight by bird-like or flapping movement of the wings.

orthogonal: The vertical reaction of the air in affording equilibrium by means of wing motion.

out-lap: Away from the starting point.

panel partition: The vertical planes in a box-kite structure.

pendular movement: To-and-fro movement like that of a pendulum.

pitch: The forward movement that would be produced by a propeller in one turn if there were no slip.

plane: Literally a flat surface; in aeroplanes a flat or curved surface.

polyplane: A multiplane.

propeller reaction: The force developed by a propeller in driving an aeroplane.

pylon: The tower required by some types of aeroplanes to start.

rarefaction side: The side opposite the compression side; the far side from the air current.

reactive current: The compressed layer of free air flowing on the reverse side of an aeroplane surface.

rear control: Stabilizing tail surface.

rigid dirigible: A dirigible in which the framework for the gas bag is rigid.

rising angle: The greatest angle of ascension.

rudder: A horizontal or vertical plane placed either at front or rear of main planes, and used for steering.

rudder braces: Rods composing the rudder framework.

single-decker: A monoplane.

single-surfaced: Aeroplane surfaces covered only on one side.

skids: Runners underneath some types of machines, used for landing.

skin-friction: The friction of the air against aeroplane surfaces.

slip: Difference between pitch of a propeller and its actual longitudinal travel.

soaring flight: Upward flight without reciprocating wing motion.

spar: A strut, a brace, etc.

stabilize: To maintain equilibrium by means of surfaces and not by mechanism.

stabilizing plane: A surface for the maintenance of equilibrium; small horizontal planes hinged to the main planes at the rear edge, and suiting the angle of the wind.

starboard side: The right side.

starting frame: Chassis.

starting rail: Monorail.

starting thrust: The impelling force required for starting.

stay: A brace in an aeroplane framework.

steadying vane: Small vertical planes, usually placed in the front control.

straight pitch: In propellers, flat instead of a helical blade surface.

strainer: A turnbuckle.

supplementary surface: A small surface which acts in unison with a larger one for a specific purpose.

supporting surfaces: Sustaining surfaces; the main planes.

tail: The framework and planes in the rear of the main plane, collectively.

tail planes: Tail vanes; the rear planes supported by the tail framework.

tail surface: The supporting surface of the tail unit.

tail wheel: A small wheel under the tail to carry it on the ground.

tie: A tension member in a framework; used also with reference to wire trussing.

tractor screw: A propeller set in front of the supporting surface instead of in the rear.

transverse spars: Cross braces.

traveling speed: The rate of speed of an aeroplane in flight; sometimes gliding speed.

triplane: An aeroplane with three supporting surfaces.

up-wind: Moving against the wind.

vanes: Used with reference to the vertical planes in the rudder.

variable pitch: In propellers, a varying angle of blade width.

vertical strut: Upright in the framework.

wake: The track of air left by an aeroplane in flight.

warping: Also called "wing warping"; the act of tipping or twisting of movable planes for the maintenance of equilibrium.

wash: The sidewise currents of air sent out by a machine in flight.

wing arc: The arc described by a moving wing.

wing bar: A longitudinal strip placed to strengthen an aeroplane surface.

wing section: The longitudinal curvature with relation to the arc of travel.

wing skid: A runner placed under a wing tip.

wing tip: The outer end of a wing surface.

wing wheel: A wheel placed under a wing tip.

weight factor: Ratio of the supporting surface to the total weight of the machine.

wire trussing: A method of wire bracing.

Wright altimeter: An instrument invented by the Wright Bros. for measuring altitude. Used in place of an aneroid barometer.

yoke: In aeroplanes, a framework of tubing which fits about the aviator's shoulders and is used for insuring lateral stability.

REFERENCE SCREW GAGES*

By FRANCIS J. BOSTOCK†

The gages described and illustrated in the following are used solely for reference purposes. They are made in standard sizes, and from them the ordinary shop or working gages are made. Reference gages are generally provided with an external thread only, which is as near to the standard size as possible; it is very convenient, however, to have on the same gage the inside diameter of the corresponding ring gage or female thread gage. This inside diameter depends upon the size, shape and number of threads per inch.

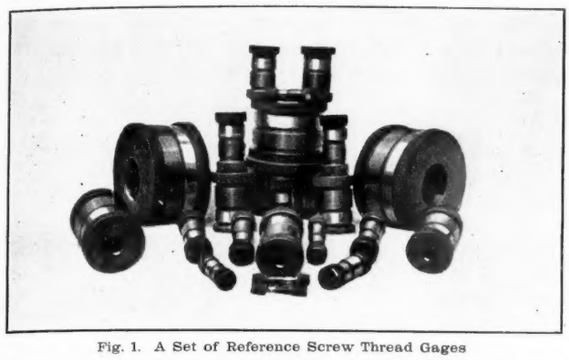
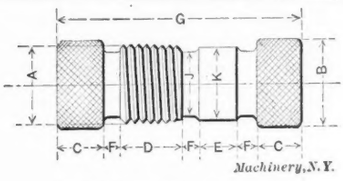


Fig. 1. A Set of Reference Screw Thread Gages

TABLE I. DIMENSIONS OF REFERENCE SCREW THREAD GAGES



English Sizes up to 1 1/2 inch
All Dimensions in Inches

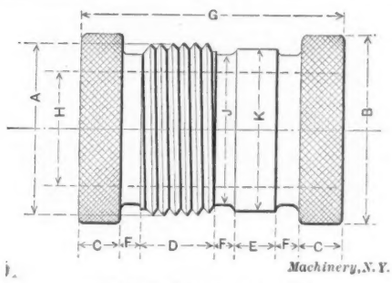
A	B	C	D	E	F	G
5/32	1/4	1/2	1/4	3/16	3/32	1 19/32
3/16	1/4	1/2	1/4	1/4	3/32	1 23/32
1/4	5/16	1/2	5/16	1/4	3/32	1 25/32
5/16	7/16	1/2	7/16	5/16	1/8	2 1/16
3/8	1/2	1/2	1/2	5/16	1/8	2 3/16
7/16	9/16	1/2	1/2	3/8	1/8	2 5/16
1/2	5/8	1/2	5/8	3/8	3/16	2 7/16
9/16	11/16	1/2	5/8	7/16	3/16	2 1/2
5/8	3/4	1/2	3/4	7/16	3/16	2 5/8
3/4	7/8	1/2	7/8	1/2	1/4	2 3/4
7/8	1	1/2	7/8	1/2	1/4	2 13/16
1	1 1/8	1/2	7/8	1/2	1/4	2 13/16
1 1/8	1 1/4	1/2	7/8	1/2	1/4	2 13/16
1 1/4	1 3/8	1/2	7/8	1/2	1/4	3
1 3/8	1 1/2	1/2	7/8	1/2	1/4	3
1 1/2	1 5/8	1/2	7/8	1/2	1/4	3

Metric Sizes up to 36 Millimeters
All Dimensions in Millimeters

A	B	C	D	E	F	G
4	6	12	6	4	2	40
5	7	12	7	4	2	41
6	8	12	8	4	2	42
8	10	12	10	4	3	47
10	12	12	12	6	3	51
12	14	12	14	6	3	53
14	16	12	14	8	4	58
16	18	12	14	8	4	58
18	20	12	14	8	4	58
20	22	12	15	10	5	64
22	24	12	15	10	5	64
24	27	12	15	10	5	64
27	30	12	15	10	5	64
30	33	12	18	12	5	69
33	36	12	18	12	5	69
36	39	12	18	12	5	69

Dimension *J* should provide for clearance for the threading tool; *K* equals inside diameter (bore) of female gage.

TABLE II. DIMENSIONS OF REFERENCE SCREW THREAD GAGES



English Sizes above 1 1/2 inch
All dimensions in Inches

A	B	C	D	E	F	G	H
1 5/8	1 3/4	1/2	1	1/2	1/4	3 3/32	1 3/4
1 3/4	1 7/8	1/2	1	1/2	1/4	3 3/32	1 3/4
2	2 1/8	1/2	1	1/2	1/4	3 3/32	1
2 1/4	2 3/8	1/2	1	1/2	1/4	3 3/32	1
2 1/2	2 5/8	1/2	1	1/2	1/4	3 3/32	1 1/4
2 3/4	2 7/8	1/2	1	1/2	1/4	3 3/32	1 1/4
3	3 1/4	1/2	1	1/2	1/4	3 3/32	1 1/2
3 1/4	3 1/2	1/2	1	1/2	1/4	3 3/32	1 1/2
3 1/2	3 3/4	1/2	1	1/2	1/4	3 3/32	2
4	4 1/4	1/2	1	1/2	1/4	4 1/4	2
4 1/2	4 3/4	1/2	1	1/2	1/4	4 1/4	2 1/2
5	5 1/4	1/2	1 1/4	1/2	1/4	4 1/4	3
5 1/2	5 3/4	1/2	1 1/4	1/2	1/4	4 1/4	3 1/2
6	6 1/4	1/2	1 1/4	1/2	1/4	4 1/4	4
6 1/2	6 3/4	1/2	1 1/4	1/2	1/4	4 1/4	4 1/2
7	7 1/4	1/2	1 1/4	1/2	1/4	4 1/4	5

Metric Sizes above 36 Millimeters
All Dimensions in Millimeters

A	B	C	D	E	F	G	H
40	43	15	20	12	5	77	20
44	48	15	20	12	5	77	20
46	50	15	20	12	5	77	20
50	54	15	20	12	5	77	30
52	56	15	20	12	5	77	30
56	60	15	25	15	8	94	30
60	65	15	25	15	8	94	40
65	70	15	25	15	8	94	40
70	75	15	25	15	8	94	40
75	80	15	25	15	8	94	50
80	85	15	25	15	8	94	50
90	95	15	25	15	8	94	60
100	105	20	30	18	10	118	70
120	125	20	30	18	10	118	90
140	145	20	30	18	10	118	100
160	165	20	30	18	10	118	120

Dimension *J* should provide for clearance for the threading tool; *K* equals inside diameter (bore) of female gage.

It is impossible to make a reference screw gage from another female gage, even when the latter is known to be of standard size, because of the difficulty of getting both threads to conform absolutely with one another, and to try them without damage to either. Besides, two gages of exactly the same size will not "go together" at all. The best method for measuring the screw thread in making the gage is, therefore, the three-wire method, which has from time to time been referred to in MACHINERY. [See MACHINERY, January, 1904, "Measuring External Thread Diameters"; September, 1907, "Measuring Screw Thread Diameters"; March, 1910, "Ball Point versus Anvil Type Thread Micrometers."] In making working gages from the reference, or master, gage, the dimensions are also transferred by means of the three-wire method.

The writer has had considerable experience in the design and procedure of manufacture of the gages shown in Fig. 1, these gages giving the dimensions both for the screw size and for the nut-bore size. At each end of the gage is a knurled collar of larger diameter than the thread, the object of which is to prevent any inexperienced person from trying a nut over the thread. These collars also prevent damage to the thread in handling and storage. The material used for these gages

* See MACHINERY, February, 1908: "Making Thread Gages." See also MACHINERY'S Reference Series No. 31, "Screw Thread Tools and Gages."

† Address: 22 Bristol Road, Bournbrook, Birmingham, England.

is a good quality of carbonized mild steel, the steel blanks being annealed before and after the rough turning. After the second annealing they are again turned all over, rough threaded and the collars knurled. They are then carbonized to a depth of from 1/32 to 1/16 inch, according to the size, and allowed to cool in the carbonizing box, after which they are reheated to a red heat (about 1500 degrees F.), quenched in water at about from 70 to 80 degrees F., and reheated or tempered to a bluish purple. They are then permitted to cool in the air in a cupboard, where they are protected from drafts. Care should be taken to heat and cool the steel uniformly, and to prevent air currents from playing upon the gage, which would distort it, or make one side harder than the other.

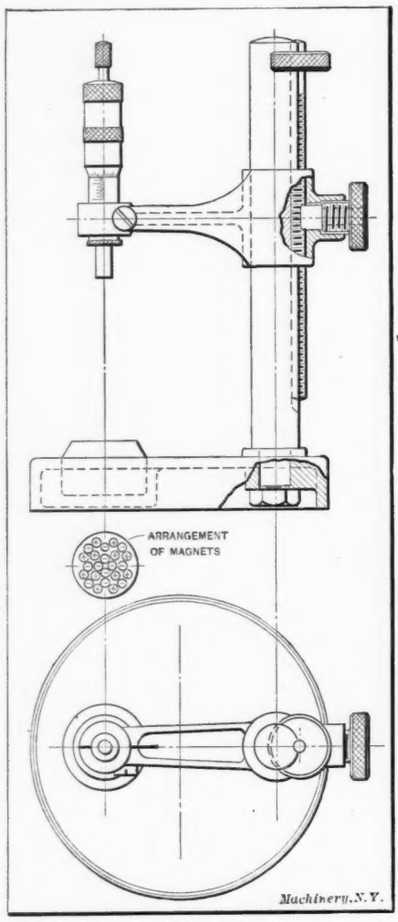


Fig. 2. Measuring Instrument for Screw-thread Diameters

After having been carbonized, the piece can still be cut conveniently, but the advantage gained is that the steel does not tear when threading, like ordinary soft machine steel, and the surface is susceptible to a high polish. After cutting, the external diameters are ground to size. It is not necessary that the reference gage should be "glass" hard, like a working gage, but it should, of course, be durable enough so as not to wear down when taking measurements for comparison. All the hardness required is obtained by the method outlined above.

An instrument for measuring the size of the thread, which has proved to be very convenient and reliable, is illustrated in Figs. 2 and 3, and consists of a cast-iron base carrying a column to which is clamped a micrometer head susceptible of adjustment by a vertical screw. Directly below the micrometer head, and imbedded in the base, is a gun-metal bushing holder in which are placed a series of magnetized cylindrical pins arranged as shown in the line engraving Fig. 2. The idea of this arrangement is to provide some means to prevent the wires from rolling off and falling, and to enable them to remain exactly where placed. The magnets have negative and positive poles as indicated.

The method of setting the instrument is merely to adjust the micrometer until it registers the exact size of the nearest size of cylindrical reference gage. Then the dimension measured over the wires can be read off directly on the micrometer, care being taken that the temperature of the reference gage and of the gage being measured is exactly the same.

The accompanying tables give dimensions of both English and metric sizes. Gages made to these dimensions have been found very satisfactory from all points of view.

* * *

The Detroit River tunnel was informally opened on July 26. The first passenger train carrying railroad officials was run through it on that date, and it is expected that regular operations will begin in October.

ALLOWABLE LOAD, AND EFFICIENCY OF WORM GEARING*

By A. P. ELTOFT†

When called upon to design a set of worm gearing for a certain drive, or select one from the catalogue of a manufacturer, the designer will find very little definite information in the standard handbooks concerning the allowable load, the allowable speed and the efficiency which may be expected—the very points which are of vital interest to him. The present article discusses these subjects.

Relation of Load to Effort

Let

P = pressure of the worm-wheel on the worm parallel to the worm-shaft,

F = force which must be applied at the pitch radius of the worm at right angles to the worm-shaft to overcome P,

α = angle of thread with a line at right angles to the axis of the worm,

f = coefficient of friction,

l = lead of worm thread,

d = pitch diameter of worm.

The normal pressure between worm and wheel then equals

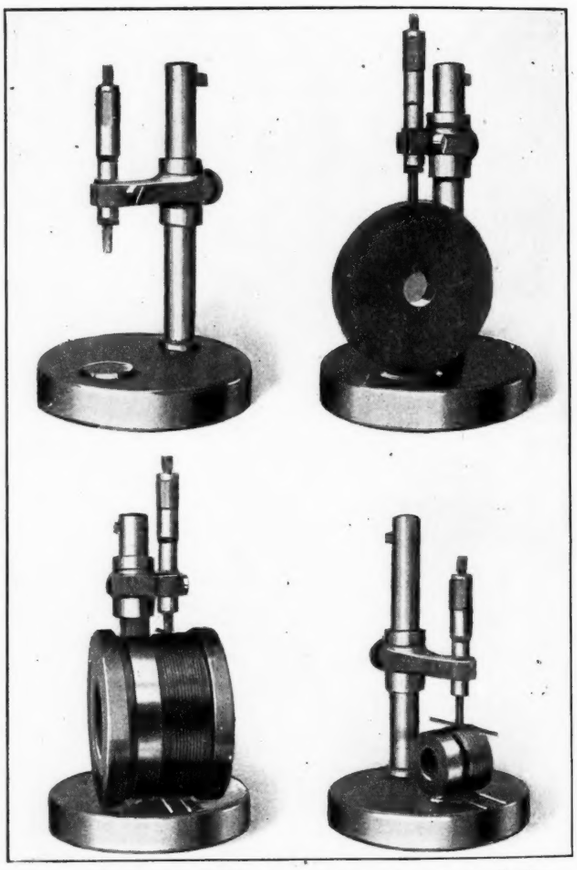


Fig. 3. The Screw-thread Measuring Instrument and its Application

$F \times \sin \alpha + P \times \cos \alpha$, and the friction f $(F \times \sin \alpha + P \times \cos \alpha)$.

Now, if the worm is revolved once, we obtain the following relation between F and P:

$$F \times \pi d = Pl + f\,(F \times \sin \alpha + P \times \cos \alpha) \frac{\pi d}{\cos \alpha}$$

As $\frac{l}{\pi d} = \tan \alpha$, the formula above may be written:

$$F = P \times \frac{f + \tan \alpha}{1 - f \tan \alpha} \qquad (1)$$

* For articles on worm gearing, previously published, see MACHINERY, December, 1908, "The Hindley Worm and Gear"; September, 1907, "Hobs for Worm-Gears"; August, 1907, "Calculating the Dimensions of Worm Gearing"; May, 1907, "Suggested Refinement in the Hobbing of Worm-Wheels"; December, 1902, "The Design of Self-locking Worm-Gears." See also MACHINERY'S Reference Series No. 1, "Worm Gearing," and MACHINERY'S Data Sheet Series No. 6, "Bevel, Spiral and Worm Gearing."

† Address: 6621 Hermitage Ave., Chicago, Ill.

This relation, giving the force F which must be applied at the pitch radius of the worm to overcome the load P at the pitch radius of the worm-gear, is often required by the designer.

Efficiency

If there were no friction, or if f equalled 0, we would have:

$$F_1 = P \tan \alpha :$$

The efficiency of the worm gearing is therefore:

$$E = \frac{F_1}{F} = \frac{\tan \alpha \ (1 - f \tan \alpha)}{f + \tan \alpha} \qquad (2)$$

Equations (1) and (2) are, strictly speaking, only correct for worm threads with vertical sides, but the sloping thread side commonly used affects the result but little.

To demonstrate the influence of the thread angle on the efficiency, the curve represented by Equation (2) with α and E as variables, and for a certain assumed value of f, has been

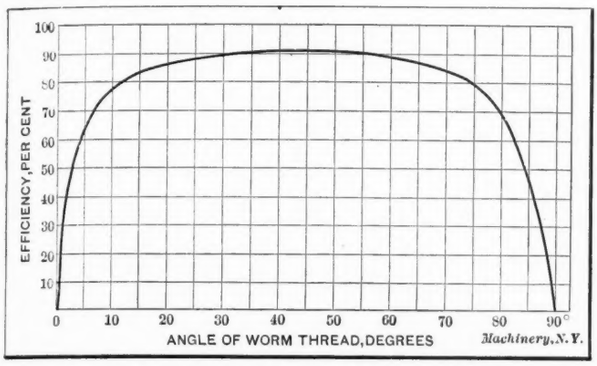


Fig. 1. Relation between Worm Thread Angle and Efficiency

plotted in Fig. 1. This curve is reproduced from "Worm and Spiral Gearing," by F. A. Halsey. It shows that the efficiency increases very rapidly with the thread angle for small angles, while for angles near the maximum efficiency, there is very little drop for a wide range of angles. It is, therefore, essential, for high efficiency, not to use thread angles that are too small. The value of f is found by experiments to vary with the speed of the rubbing surfaces. (See Transactions of the American Society of Mechanical Engineers, Vol. 7, page 273.) For values of f for various speeds, see the accompanying table.

Allowable Load

It would seem reasonable to assume the allowable pressure on gear teeth under otherwise equal conditions to be expressed by

$$P = Cpb \qquad (3)$$

where p = pitch, b = width of gear teeth, and C = a constant for the given speed.

For very slow speed, where there is no danger of over-heating, and where the only questions to be taken into account, are the strength and the resistance to abrasion, the above equation is obviously correct if we assume some standard ratio of worm diameter to wheel face. A pitch diameter of worm equal to 1.5 times the face of the wheel (corresponding to a face angle of 76 degrees) is about right.

For higher speeds, the amount of frictional work transformed into heat may cause an excessive rise in temperature before the worm, or casing surrounding the worm, is able to carry off the same amount of heat as is developed, and the limiting load will be determined thereby. The ability of the worm or casing to carry off heat is proportional to the surface, which, again, is approximately proportional to the product pb of the pitch and width of the gear teeth; hence, Equation (3) is approximately correct in this case also. [This equation is given in "Des Ingenieurs Taschenbuch" (Hütte).]

The value of the factor C varies with the speed and must be determined by experiment. The most complete experiments to this effect are, to the writer's knowledge, those of C. Bach and E. Roser, published in *Zeitschrift des Vereines Deutscher Ingenieure*, Feb. 14, 1903. These experiments were made with a three-threaded steel worm, not hardened, 76.6 millimeters (3 inches), pitch diameter; 25.4 millimeters (1 inch), pitch; 17 degrees 34 minutes, thread angle; 148 millimeters (5 13/16 inch) long. The worm-wheel was of bronze, 242.6 millimeters (9 9/16 inch) pitch diameter, with milled teeth, 78 millimeters (3 1/16 inch) wide measured on the arc, 30 teeth, speed ratio 1 to 10, with ball bearings for worm shaft, and oil bath of extremely viscous oil.

In the experiments, the load on the teeth varied from 111 kilograms (244 pounds) to 1257 kilograms (2765 pounds) and the speed varied from 2185 R.P.M. to 64 R.P.M. The temperature of the oil bath and that of the surrounding air was observed until the difference reached a constant value. Corresponding values of load and speed for constant temperature difference were ascertained and an attempt to express the relation by an equation gave the following rather lengthy expression:

$$P = Cpb = [a \ (t_o - t_e) + d] \ pb. \qquad (4)$$

in which

$$a = \frac{0.0669}{V} + 0.4192$$

$$d = \frac{109.1}{V + 2.75} - 24.92$$

t_o = temperature of oil in degrees C.,
t_e = temperature of air in degrees C.,
V = sliding velocity at pitch line in meters per second.

The curves represented by Equation (4) are distinctly hyperbolic in character. Two of these curves have been plotted in Fig. 2, one for a temperature difference of 50 degrees C. and one for 70 degrees C.

The accompanying table shows the loads for various speeds, calculated from Equation (4) and transformed into English units, for a difference in temperature of 90 degrees F. (50 degrees C.). In the same table are given coefficients of friction as deduced by Unwin from Lewis's experiments. This table of load used with discretion and with due consideration for the various individual conditions associated with the drive in contemplation, may, in the writer's opinion, very well be made the basis for worm-gear design in average cases and where a temperature rise of 90 degrees F. (50 degrees C.) is al-

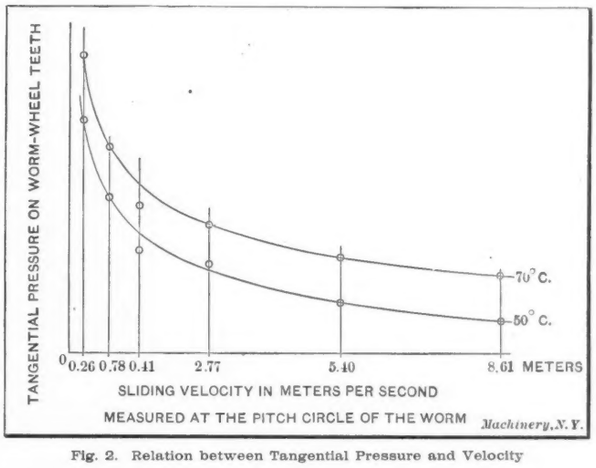


Fig. 2. Relation between Tangential Pressure and Velocity

lowable. The loads given are for continuous service, and as it will take several minutes, perhaps hours, before the constant temperature is reached, a higher load will be justified for intermittent service, where the oil has time to cool down. It should be kept in mind that the danger of abrasion will, of course, depend, on the temperature of the oil, and not on the temperature difference; if, therefore, the gearing is installed in a place where the surrounding temperature is kept low, the temperature difference can be correspondingly increased and *vice versa*. The danger of abrasion will also, to a large extent, depend on the character of the lubricant, in that a very viscous oil will offer greater resistance to the squeezing out of the oil film between the rubbing surfaces than the less viscous.

It should be remembered also that a gear with many teeth gives a better contact with the worm both on account of the

flatter curve of the engaging segment and the larger average radii of curvature of its teeth. This has particular reference to the heavy loads at slow speed, where the question of temperature does not enter.

The angle of thread (the helix angle) does not appear in the formula given, as it has no direct bearing on the question of allowable load and speed of rubbing surfaces. As previously mentioned, the angle of thread has, however, a direct influence on the efficiency of the gearing. Given, for instance, two worms of the same diameter, one having a thread angle twice as great as the other, carrying the same load on the gear teeth and running at the same speed; there is no reason at all why one should be more successful than the other as far as wearing qualities are concerned, but it must be remembered that the first one is transmitting twice the horsepower of the other, and will obviously give much better efficiency.

With the allowable load decreasing as the speed increases, as

TABLE OF LOAD ON GEAR TEETH

Load per unit of the product (pitch × width of tooth), for 90-degree F. temperature difference between oil and surrounding air. More than 1000 pounds per unit of product (pitch × width of tooth) should not be allowed under ordinary circumstances. Cut-bronze gear, cut-steel worm.

Velocity in feet per minute	Load in pounds per unit of (pitch × width of tooth)	Coefficient of friction	Velocity in feet per minute	Load in pounds per unit of (pitch × width of tooth)	Coefficient of friction
5	1000	0.146	200	403	.....
10	1000	0.116	250	371	.....
20	956	0.090	300	341	.....
30	790	.....	350	315	.....
40	703	0.070	400	292	.....
50	646	.....	500	257	.....
75	564	.....	600	228	.....
80	....	0.054	700	206	.....
100	514		800	185	.....
125	477	.....	900	167	.....
150	448	.....	1000	151	.....
175	424	.....	1200	128	.....

provided for by the formula and table given, a speed of rubbing surfaces as high as 1000 feet per minute, or even higher, can undoubtedly be used with success for cut gearing, which also has been demonstrated repeatedly in practice. In the tests by Bach and Roser, the speed was carried as high as 8.76 meters per second (1724 feet per minute), with a load of 370 kilograms (814 pounds) and a temperature difference of 80.5 degrees C. (126.9 degrees F.) with no apparent cutting. The loads given represent tangential loads at right angles to the worm-gear shaft. The actual pressure between the rubbing surfaces will be more, and will increase with the angle of thread, but the increase for gears in common use (less than 20-degree thread angle) is not very great.

Concerning the coefficient of friction f, this has not been deduced for higher speeds than 80 feet per minute, but it will be seen that there is a general tendency for the value of f to decrease as the speed increases.

Except for hand-operated gearing, or for machinery which is only operated occasionally and for a very short time, the worm and gear should be enclosed in an oil casing and the worm always placed below the gear to insure the submersion of the rubbing surfaces in oil. Except in the above-mentioned cases, machine-cut worms and wheels should also always be used. Hardened steel worms working with bronze wheels have proved to give good satisfaction, because this combination wears longer than cast iron or steel and cast iron.

Self-locking Worm Gearing

A set of worm gearing will be self-locking when the thread angle is equal to, or smaller than, the angle of friction. From Equation (2) we obtain, by making $f = \tan \alpha$, the efficiency of worm gearing having a thread angle just small enough to be self-locking, as follows:

$$E_1 = \frac{\tan \alpha \ (1 - \tan^2 \alpha)}{2 \tan \alpha} = \tfrac{1}{2} \ (1 - \tan^2 \alpha) \qquad (5)$$

Equation (5) gives a maximum of E_1 for $\tan \alpha = 0$ or $\alpha = 0$, and this value is E_1 max. $= \frac{1}{2}$.

From this it will be seen that it is impossible to obtain an efficiency greater than 0.5 if the gears are to be self-locking in themselves. Of course, there will always be some friction in the worm shaft bearings and other parts of the machinery which may prevent the pressure on the worm-gear from actually turning the machinery as a whole backwards even if the angle of thread is larger than that of friction. This, in connection with the fact that the efficiency for backward movement is low, is probably the reason why many worm-gear drives, applied as self-locking, have angles of thread far in excess of the friction angle, and still seem to work satisfactorily.

On account of the variable coefficient of friction, the angle of thread which may safely be used for self-locking gears will also depend largely on the speed with which the machine is run backward, or, in other words, the speed with which the load is lowered or eased off by means of the worm-gear. If the machine is never run but one way, and the worm-gear applied as safety device to prevent backward movement in case of accident, then the load would have to start the worm shaft rotating, and a larger angle of thread could undoubtedly be used.

An Example from Practice

To indicate the use of the formulas and table in practical work, the following example has been prepared: Assume a set of worm gearing used for driving a package elevator with the worm-gear shaft running at a speed of 5 R.P.M. The required turning moment is 42,000 inch-pounds. It is desired to have the worm gearing self-locking to prevent the elevator from running backward in case the driving belt breaks or jumps off.

As the elevator must come to a stop before it can commence to run backward it is only necessary to have a thread angle equal to or smaller than the angle of friction for rest. Assuming the coefficient of friction to be at least 0.15 at rest, the thread angle α will be determined by $\tan \alpha = 0.15$, or $\alpha = 8\frac{1}{2}$ degrees. If the speed of the worm shaft is not dependent on other conditions, we have a choice between a single- and a double-threaded worm. A single-threaded worm of $1\frac{3}{4}$ inch pitch would have a diameter $= \frac{1\frac{3}{4}}{0.15\pi} = 3.71$ inches. This may not be enough to allow for a worm shaft of sufficient strength; besides it would give a very narrow face to the worm-gear. We, therefore, probably prefer to use a double-threaded worm, the pitch diameter of which will be $\frac{1\frac{3}{4} \times 2}{0.15\pi} = 7.42$ inches. The face of the worm-gear will then be

$$2/3 \times 7.42 = 4.95 \text{ inches, or, say, 5 inches.}$$

Assuming a worm-gear of 28 inches pitch diameter, $1\frac{3}{4}$ inch pitch, and 50 teeth, the worm shaft will be running $5 \times \frac{50}{2} =$ 125 R.P.M., which gives a speed of rubbing of $\frac{\pi \times 7.42 \times 125}{12 \times \cos 8\frac{1}{2} \text{ deg.}} = 247$ feet per minute.

Looking at the table, we find for a speed of 250 feet per minute an allowable load of 371 pounds per unit of product (pitch × width of tooth). The total allowable load in our case will be $371 \times 1\frac{3}{4} \times 5 = 3246$ pounds. This load at 14 inches radius gives a turning moment of $14 \times 3246 = 45{,}444$ inch-pounds, while only 42,000 inch-pounds is required.

If the above machine were applied for lowering packages instead of elevating same as previously assumed, the gearing would have to lock while running at a full speed of 247 feet per minute, at which speed we would not have a friction coefficient of more than 0.05, at the most, which would correspond to an angle of thread determined by $\tan \beta = 0.05$, or $\beta = 2$ degrees 50 minutes approximately, and the gear with a thread angle of $8\frac{1}{2}$ degrees could not be expected to lock.

To find the efficiency of the above gearing when running at full speed, assume a coefficient of friction of 0.05, and apply Formula (2) which gives

$$E = \frac{\tan \alpha \ (1 - f \tan \alpha)}{f + \tan \alpha} = \frac{0.15 \ (1 - 0.05 \times 0.15)}{0.05 + 0.15} =$$

74 per cent.

This is the efficiency of the worm gearing only and does not allow for the friction loss in the worm-gear shaft nor any frictional loss in the other parts of the machine.

To find the effort F which must be exerted at the pitch radius of the worm to turn the worm shaft with a load $= \frac{42000}{14} =$ 3000 pounds, at the worm-gear periphery, apply Formula (1) which gives (for $f = 0.15$ at starting):

$$F = P \times \frac{f + \tan \alpha}{1 - f \tan \alpha} = 3000 \times \frac{0.15 + 0.15}{1 - 0.15 \times 0.15} = 921 \text{ pounds.}$$

To this should be added the friction in the worm-shaft bearings reduced to the same radius.

* * *

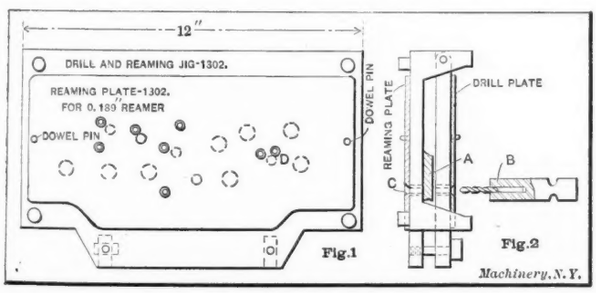
DRILLING ADDING MACHINE SIDE FRAMES BY PLATE METHOD

By A. C. LINDHOLM*

The following problem of drilling and reaming a delicate casting having forty-one holes, varying in diameter from 0.125 inch to 0.375 inch, making sure that all holes were finished before removing the casting from the jig, was my lot to solve. Not having a multiple spindle drill press, so as to be able to drill a number of holes at once, the job had to be done on a three-spindle drill press, one hole being drilled at a time. Various schemes were tried to make time on the job, but somehow there were always one or more holes that were omitted, and most always the reaming, so that when the work was gaged the error was found out, which necessitated rejigging the piece. A method which proved a failure was tried previous to the adoption of the plate method, involving the following idea:

The holes were marked on the jig by numbers and on the drill and reamer holders likewise. For example: 0.156-inch holes were marked Number 2; 0.189-inch holes, Number 3; 0.250-inch holes, Number 4, etc. The time expended in looking for the right number of hole for the corresponding drill or reamer, besides the liability of skipping holes and of forcing a large reamer into a small bushing, was enough to abolish the idea.

Referring to Figs. 1 and 2, in explaining the plate method, it will be seen that a simple drill jig of the leaf type is shown,



Figs. 1 and 2. Method of Using Plates on Drill Jigs to insure All Holes being drilled and reamed

in which the work A is drilled from one side and reamed from the opposite; that is, drilled from the leaf or hinged side and reamed from the solid or positive side to insure correct alignment of the hole with the flat side of the work. In this casting eight holes 0.189 inch diameter, ten holes 0.177 inch diameter, four holes 0.125 inch diameter, and four holes 0.375 inch diameter, were to be reamed. To drill or ream the 0.189-inch diameter holes, a plate was made from 1/16-inch thick sheet steel and located on the dowel pins. In this plate the holes correspond with the 0.189-inch holes in the jig, showing the operator just where these particular holes are located, and covering all others, thus eliminating all chances of placing the reamer anywhere but in the proper holes. The holes in the plate are about 1/32-inch diameter larger than the drill or reamer holes in the bushings and chamfered at C, so that, when machining, the drill or reamer will have perfect freedom to enter, and when withdrawing them, small chips or dust will be deposited around the hole, indicating that the hole has been drilled or reamed. Having drilled or reamed this size, the plate is removed and another put on having the 0.177-inch size, and then the plate containing two sizes, 0.125 inch and 0.375 inch. These sizes vary greatly, and the operator is not so likely to try to enter a 3/8-inch reamer into a 1/8-inch hole. Each plate has marked on it the size of the drill or reamer to be used, as has also the holder B, which is of the slip chuck type.

Another case for the plate method is presented in Fig. 3, which is a little different; that is, the requirements are not the same as for the casting A (Fig. 2), inasmuch as some of the holes in the work W are drilled only part way through. However, the same idea is carried out in regard to selecting and locating the holes, but the plate A has bosses or shouldered bushings C and D of various heights, so that a holder containing a drill, set out far enough to drill the proper depth for one hole, will also drill the proper depth for the other. For instance, if the drill in holder B (Fig. 2) is set so that it will drill the center hole in W (Fig. 3) to the proper

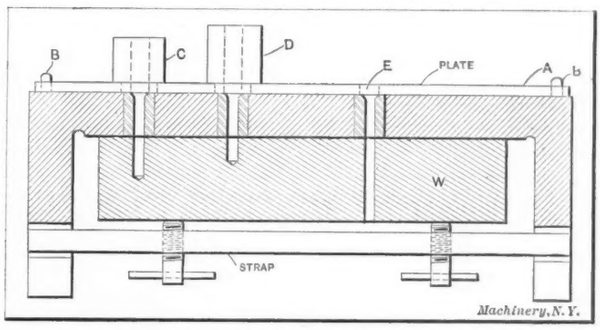


Fig. 3. Simple Method of Drilling Holes to Various Depths

depth, the same tool will drill C and E. This obviates the necessity of setting the spindle to obtain different depths, and in this case a drill press with but one spindle can be used as advantageously as one with two or three. In the case of Fig. 3, W is a rectangular block 60 inches by 4 inches by 1 3/16 inch, having 30 holes drilled to various depths. Some of these holes are tapped, and as this is done in a tapping machine, the plate method is again used for selecting the proper holes to be tapped.

For obtaining results satisfactory as to the quantity and quality of the work produced, by the adoption of as near a fool-proof method as possible, the writer has found this simple and inexpensive idea the best.

* * *

POWER REQUIRED TO DRIVE CRANES

The following data on the power required to drive cranes, representing the practice of the Morgan Engineering Co., Alliance, Ohio, are given by the *Industrial Engineering and Engineering Digest*. The power required to drive the different parts of cranes is determined by allowing a certain percentage for friction over the power required to move the dead load without friction. On hoist motions 33.3 per cent is allowed for friction of the moving parts, the capacity of the motor thus being one-third greater than if friction were neglected. For bridge and trolley motions a journal friction of the track wheel axles of 10 per cent of the total weight of the moving parts of the crane and the load, is allowed. To this is added an allowance of 33.3 per cent of the horsepower required to drive the crane and load with the track wheel axle friction taken into account. This additional amount covers the friction of the gearing.

* * *

A transformer for a current of 500,000 volts has been built by the General Electric Co. of Berlin, Germany, for experiments with insulating materials. The voltage of the current transformed is from 1,040 to 2,080 volts. The transformer proper is immersed in an oil tank containing 2,000 gallons of oil which acts as insulating material. The transformer weighs 11,000 pounds without the oil, and has with the oil tank, a length of 10 feet, a width of 6 feet, and a height of 8 feet. With the projecting high pressure insulators the total height is nearly 15 feet.

* Address: 586 Dixwell Ave., New Haven, Conn.

PRACTICAL HINTS FOR DIEMAKERS—1

BLANKING AND PIERCING DIES

By RICHARD L. BREUL*

Richard L. Breul†

It is absolutely necessary if accurate work is to be produced by punches and dies that the templet be accurate. This is one of the first points which the diemaker should be sure of before commencing to make the punch or die. When templets are made from copper and brass, a good method of coloring them is to apply some ordinary steel coppering solution, and mix with this a little steel filings; then rub this around on the brass sheet.

Always remove at least 1/16 inch from the top face of the die blank, as this amount is generally decarbonized and will not harden perfectly. In laying out the blanking and piercing die always allow for scrap between the blanks. This amount should never be less than the thickness of the stock. When putting on a gage plate, always allow for variations in the stock, and the spreading of the metal while being worked. A good method of working out die blanks after the core has been removed, is to set them up in the shaper vise between two parallel strips which should hold them at the angle required for clearance, and then remove the stock with a tool made similar to an ordinary internal keyseating tool. If the hole in the die is large enough to permit adopting this method, it has an added advantage of leaving the sides perfectly straight, which simplifies the operation of filing them to shape. The stock should be removed to within about 1/64 inch of the finish line, and then the mouth of the die beveled with a file to the line, before the finishing cut is taken. When filing out the die, the angle to which the die is beveled should be adhered to as much as possible, as trouble will occur after the die is hardened, if it has not been filed on a straight bevel but is slightly larger at the mouth. This will cause the blanks to scrape on the sides of the die when being forced through, which sometimes bends them out of shape. The templet should be worked through the die from the back, as in this way the correct shape is more easily attained. All the guide pins in the punches should be located by means of this templet.

Do not stamp any necessary information on the top face of the blanking die, as it is generally removed when the die is ground. It is usually advisable to stamp whatever is necessary on the front edge of the die; but, if that is not convenient it should be put on the stripper plate. The bottom of the die should be ground level if good results are to be expected. In filing out the die, it is convenient to have a set of small squares which are set off from ninety degrees, an amount equal to the angle required on the die for clearance. These may be made from 1/16-inch sheet steel with the base ½ inch wide by 2 inches long, and the beam ⅛ wide by 1½ inch long, or they can be made to suit the requirements. It is generally found advisable to have these ranging from ½ degree to 2 degrees varying by ½ degrees. The number of degrees that these are set off from 90 should be marked on the various squares to designate them. It is generally advisable to harden a blanking die at a low heat to prevent it from springing out of shape and cracking. The following is a solution which has been found to give very satisfactory results for this purpose. Into pure rain water mix enough salt to float a raw potato. To eight gallons of the brine, add one pint of oil of vitriol. After hardening the die in this solution it should be dipped in strong, hot soda water, which will keep it from rusting.

When machining a punch which has inside corners, holes should be drilled in the corner close to the finished line, and as deep as the straight part of the punch extends. The size of the drill, of course, should correspond to the radius required on the punch. The punch should be beveled on the edge at an angle of about 45 degrees to a little below the finished line. This enables the punch to start centrally when shearing it into the die, and also simplifies the locating of it. This beveled portion can be ground off after the punch is hardened. When shearing the punch through the die, be sure that it stands perfectly square with the top face of the die. Care should be taken when shearing the punch through the die to see that it does not remove too much stock. If the die removes a nice curling chip from the punch it is not removing too much stock, but if the chip cracks and breaks as it is severed, it is obvious that it is removing too much stock, and before going any further the punch should be removed and reduced in size, at the point or points where the die was removing too much stock. It is advisable always to use oil on the punch when shearing it through the die.

Punches for piercing and blanking copper should be polished quite smooth, as copper clings tightly and is difficult to strip from the punch. If, on the other hand, the punch is left rough, the force necessary to strip the blank from the punch is very likely to bend it out of shape or to break the punch.

When making blanking or piercing punches for plain circular work, hold the punches by the shank in a punch bolster, and set this up to run true in the lathe. The outside diameter is then turned to the required size and the hole for the guide pin is also drilled. Making the punch in this way insures the guide pin being in the exact center of the punch.

Small perforating punches should be hardened their entire length, otherwise they will be upset or bent, if thick metal is to be perforated. The punches should also be carefully examined after hardening and tempering, and those which have been bent or sprung in the hardening should be carefully straightened. Piercing punches in compound dies are steadied by the knock-out while operating on the stock. The punch is made a sliding fit in the knock-out, and the knock-out is also made a sliding fit in the die. When perforating thick metal where the strain on the press is great, a good method to reduce the pressure, is to make each second punch lower than the preceding one an amount equal to the thickness of the stock. This, as can be seen, will reduce the pressure, as half the punches are through the stock before the remaining half operate. When heavy stock is being blanked or pierced, punches are not required to fit as snugly as when the metal is thin. It is generally found after hardening small piercing punches, that although the holes in the punch holder are true with the die, the punches do not line up. This is because they have bent slightly in hardening. They can usually be brought into alignment by giving those that do not enter half a turn, but if this does not work, they should be removed and straightened. When a large and a small piercing punch are too close together to allow both being set in the punch holder, the smaller punch is set in the larger one, and securely held in position.

In fitting the punch into the die, scrapers can generally be used to good advantage, as the points which are high can be reduced by scraping where it would be more difficult to file. These scrapers may be made in various shapes to suit the requirements. When piercing holes in a circular piece of work, the radius on the bottom face of the punch should be less than the radius on the piece, so that the outer edge of the punch will strike the metal first. If this precaution is not taken and the punch made the same or a greater radius than the piece, the work will be changed from its original shape.

Compound dies are made without clearance, and the blanks are ejected by the knock-out as soon as the punch leaves the die. The piercing holes in the punch, however, should be taper reamed and larger at the top so that the piercings will pass up through the punch easily. The throwing out of the piercings from a compound die is aided by setting the die in an inclined press. If a double compound die is required to

* Address: 849 Hancock Ave., Bridgeport, Conn.

†Richard L. Breul was born in Bridgeport, Conn., 1878. He served an apprenticeship in the machine shop of his father, R. A. Breul, builder of special and automatic machinery. He has since worked for the Driggs-Seabury Gun and Ammunition Co., Derby, Conn., Wheeler & Wilson Sewing Machine Co., Bridgeport Brass Co., and the R. P. K. Pressed Metal Co., all three of Bridgeport, Conn. His specialties are die-making, model and experimental work.

produce two blanks on one stroke of the press, care should be taken to see that the knock-outs are ground to the same height, and also that the blanking punches are perfectly level, so that both blanks will be flattened alike. The spring or rubber pad which operates the knock-out in the compound die should be adjusted tighter than necessary to insure the blanks being removed. The knock-out should just bring the blank to the surface of the die.

Guide pins should be made slightly smaller than the hole in the blank and should be straight for the thickness of the stock, and then rounded off similar to the point of an acorn. The heads of all guide pins should be turned true with the shank. Care should be taken to see that the guide pins are also exactly in line with the piercings. If they are not in line they have a tendency to twitch the metal around, so that after a few blanks have been punched, they will be found to run off the strip. Precaution should be taken to see that the stock does not cramp between the guide pins and the stop, or between the guide pins and the back gage, because if this is neglected it will generally result in some broken punches. When the piercings are very small the punch should be provided with a spring guide pin, so that if the pin misses the pierced hole in the blank, it will spring back into the punch and nothing is spoiled except the blank.

When a number of small round piercing dies of the same size are to be made, after having turned and bored them all to the same size they can be taper reamed from the back very readily by holding them in a chuck which runs true, and using a taper reamer with a bushing located on it, this bushing acting as a stop. The piercing bushings can then be reamed out from the back to the exact size by using the bushing located on the reamer as a stop. Always provide clearance holes in the die bed under the piercing bushings for the piercings to drop out. These holes should be larger than the holes in the piercing bushings, so that the latter can easily be driven out. After having completed the die and punch, before taking them to the press, see that all guide pins when in the punch locate accurately in the piercing holes in the die, and also see that all the punches line up perfectly.

* * *

From an early treatise by Moxon, published in 1680 in England, it is certain that at that time the lathe was developed to a point where it was possible to turn out high-class ornamental woodwork, including oval shapes, but anything more than this was beyond its power until the slide-rest was invented. Devices for clamping the cutting tools in a fixed position were employed comparatively early, but the first appearance of the slide-rest dates from 1772. Complete drawings and details of an excellent slide-rest were given in that year in a French encyclopedia. As early as in 1741, Hindley, a York clock-maker, produced a screw-cutting lathe with change gears. This, of course, was a very small machine, and in fact the clock-makers of that day seemed to have a monopoly of mechanical ingenuity. Attempts to produce machinery to replace the work of human hands were made early; thus, for example, in 1732 Wyatt endeavored to make a machine for cutting files, but was not successful.

* * *

According to the *Foundry*, the proper proportions of a copper alloy for soldering irons, copper hammers and all copper castings which do not require high electric conductivity, are obtained by mixing 96 pounds of copper and 4 pounds of zinc. Two tablespoonfuls of salt should be added to the copper when first charged. The zinc should be added after the copper is melted. The mixture is thoroughly stirred and the metal is allowed to superheat for a few minutes before being cast.

* * *

The record for altitude in aeroplane flying was broken by Walter Brookins with the Wright biplane at Atlantic City on July 9, when the aeronaut, by a steady ascent of fifty-three minutes, reached the height of 6175 feet, as observed from the ground. At this height his fuel gave out and he was obliged to descend in a gliding flight from this altitude, which was done successfully in ten minutes. Through this flight he won a prize of $5000.

MACHINE SHOP PRACTICE*

SOME POINTS ON LATHE WORK

By W. S. LEONARD†

As the work described in the Shop Operation Sheet accompanying this number of MACHINERY, which explains the turning operations on a chuck-plate casting, is typical of much of the work that is done on the ordinary engine lathe, it may not be amiss to offer some further considerations of a general character on the subject.

When setting a casting in a lathe chuck (as explained in the sheet referred to) unevenness on that part gripped by the chuck jaws will sometimes cause it to run "out of true," even when held in a self-centering chuck. This trouble is usually caused by a ragged edge or ridge along the parting line of the casting where the foundry flasks come together, and generally this and all rough bumps should be reduced on the grinder or removed with a chisel and old file before the casting is brought to the lathe.

The side tool referred to in paragraph 4 (Operation Sheet No. 145) is not the old-style thin-edge side tool (though such a tool would answer for the finishing cut), but it is one of

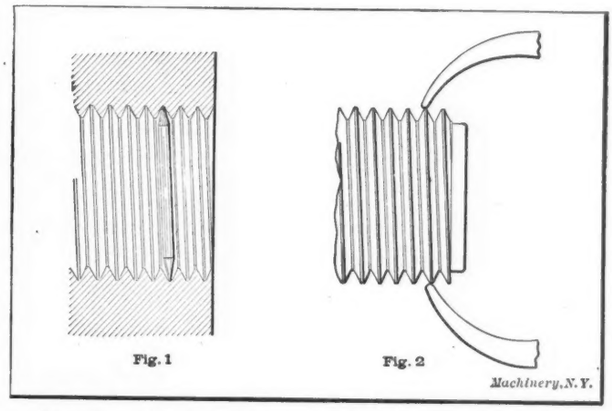


Fig. 1. Internal Thread Gage Fig. 2. Calipering Thread

the stouter variety, which may be used advantageously for both roughing and finishing. Skillful machinists can take a fine finishing cut with a side tool that will make the face of the work look as though a scraper had been used. In fact, these fine cuts are scraping cuts, and it is the practice of the writer to run the lathe almost as fast for this work as is done when a scraper is used. To avoid chattering, the face contact of the tool should be reduced by setting the tool at a slight angle, giving it a slight bearing near its point. If the fine effect alluded to is not required, the tool should be given a wider bearing and be fed faster, and the speed of the lathe should be reduced. It should be understood that a diamond point, half-diamond point, or other roughing tool might be used for both roughing and finishing cuts, either on the face or cylindrical part of such work. It is largely a matter of adjustment for contact, and perhaps slight modification of the point of the tool by grinding. Where much duplicate work is done there should be a separate tool for finishing, if a fair finish is required. The roughing tool soon gets too dull for nice cuts, and it saves time in grinding to have two tools. When a large quantity of duplicate work is to be done, it will pay to determine by experiment the best shape of tool, speed of lathe, etc., with reference to economy of time and quality of work.

In paragraph 7 the operator is reminded of the necessity of rounding the inner corner of the hub if the lathe spindle is filletted under the collar. The casting would be less likely to get bruised in such a manner as to cause the chuck to run out of true if both the inner and outer hub corners were rounded, whether this were otherwise required or not. The corners may be rounded by tools filed to the shape of the curve, when a large quantity of duplicate work is to be done. When cutting a thread in the average casting of the character

* With Shop Operation Sheet Supplement.
† Address: 100 Josephine St., Atlanta, Ga.

referred to in the Operation Sheet, there will be little or no time lost if the lathe be reversed for successive cuts; but if the hole to be threaded is long, it would save time to "catch the thread" without reversing the lathe. To do this, stop the lathe just after the tool reaches the end of the thread and make a chalk mark on the periphery of the chuck in line with some fixed point on the lathe. Next disengage the lead-screw nut and move the carriage back for the next cut a distance which must be divisible *without a remainder* by the lead of the thread being cut and that of the lathe lead-screw. As most threads are integral to the inch, it is a common practice to move the carriage back a whole number of inches as measured by a steel scale, the distance being marked by chalk on the lathe ways. If the lathe is provided with an adjustable carriage stop, this should be used to mark the return position of the carriage. If this position be determined according to the foregoing instructions, the lead-screw nut will engage correctly and the tool will follow the thread as accurately as though the lathe had been reversed. For each succeeding cut the lathe spindle must be brought to rest at the position established for the first cut, and it must be kept in that position until the lead-screw nut is re-engaged for another cut.

In paragraph 7 of Operation Sheet, No. 146, the workman is instructed to use either a threaded plug gage or inside thread calipers for testing the thread. In some small shops neither of these tools is available. In such a case a piece of wire about ⅛ inch in diameter, cut to the required length, and having its ends filed to conical points, will answer very well in place of the calipers; indeed, many machinists would prefer the wire. When making a gage of this kind, the calipers are first set to the outside diameter of the thread as indicated in Fig. 1; the gage is then fitted to the calipers and used as shown in Fig. 2. Care must be taken to file the wire to a point fine enough to enter to the extreme bottom of the thread. If by accident this gage be filed too short it may easily be stretched by holding it on a solid piece of metal and giving it a few peening blows near the middle with the hammer. It may be stated in this connection that, generally, when a piece of work (whether threaded or plain) is to be machined to fit some repair job outside of the shop, a wire gage "made on the spot" is more dependable than calipers, because the latter may happen to fall or otherwise be altered. In some cases the wire gage is sent through the mails, it being accompanied by a letter of instructions to the shop which is to make the repair piece.

If the compound rest be set parallel with the lathe ways while cutting a thread, care must be taken to have the gib screws adjusted tightly; otherwise the rest may be drawn forward and spoil the thread. This is most likely to occur when cutting a thread in a hub having foundry "blow holes." When the tool comes in contact with the blow hole, it may spring forward, if the rest be sufficiently loose to permit this. Many workmen prefer to set the rest to the angle of the thread and use its crank to feed the tool instead of the cross-feed crank. In any case, the gib screws for both the cross-feed and the compound-rest should be snugly adjusted when cutting threads.

The experienced machinist knows that if oil by any means gets on the thread of a casting while the thread is being cut it will cause the fine chips and dust to adhere to the thread, and give trouble while the casting is being tried on its mating piece. Because of this difficulty some machinists will try a chuck-plate casting on its spindle without using any lubricant. In a number of cases in which this plan was followed, the writer has known the casting to be so firmly galled on the lathe spindle as to necessitate its being cut off with a hammer and chisel, or turned off with a lathe tool. It is necessary, therefore, to use some lubricant. A few drops of oil on clean waste, the latter being wiped around the thread of the spindle (not in the casting), will answer the purpose of lubrication without causing grit and chips to adhere.

An old chuck that has not been properly taken care of will sometimes stick and refuse to go up against the lathe spindle collar. This is caused by grit in the thread. It has been the practice of the writer to cut a narrow groove like a keyway in the chuck-plate bore. The grit rubs off into this groove. A similar groove cut on the spindle would be an additional advantage. The practice of dropping chucks and faceplates under the lathe where they catch oil, dirt and grit should not be tolerated, and such slovenly methods will not be followed by the conscientious workman. It is a good plan to have a rack with stout wooden plugs projecting outward and hang all chucks and faceplates on these plugs. Each lathe might have its rack, which should, of course, be near the lathe.

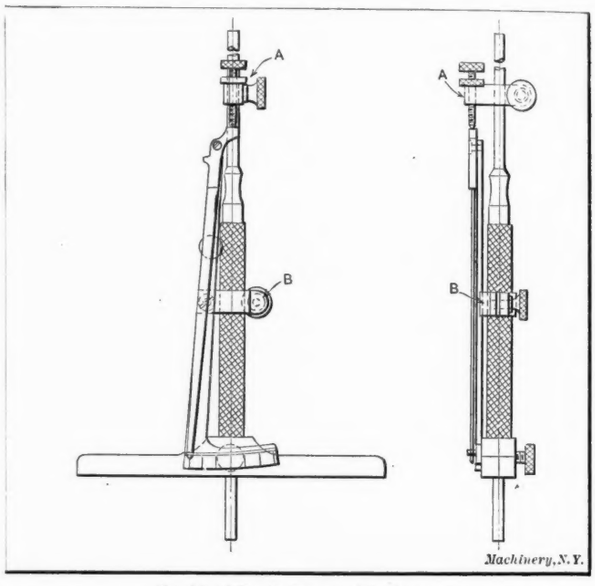
* * *

DEPTH GAGE WITH INDICATOR ATTACHMENT

By JETHART

The accompanying engraving shows a Brown & Sharpe spring depth gage to which has been attached a Starrett test indicator. This combination I have found very useful when working out recesses in dies, etc., which have to be scraped parallel with the face of the die, and similar work.

The indicator is attached to the depth gage by the clip *B*. The rod which carries the clamping disks on the indicator, which was riveted to the indicator frame, was removed and the hole tapped for a suitable sized screw, by which the indicator is attached to clip *B*. By threading the end of the clamping rod to fit the tapped hole in the indicator frame, it takes only a minute or so to change from the depth gage to the regular indicator again. The clip *A* is attached to the upper end of the measuring rod of the depth gage. The vertical screw with the check nut, allows the indicator to be adjusted to any graduation desired. The end of this screw is rounded and hardened.



Combined Depth Gage and Indicator

The action of this combination will be clearly seen from the illustration. The spring in the depth gage forces the measuring rod always to the bottom of the recess or hole, and as the vertical screw in clip *A* is adjusted to some graduation on the indicator, when the gage is moved from one end of the recess to the other, the indicator shows any variation in depth.

As the measuring rod in the depth gage was free to revolve, some means had to be found to keep it from turning. This was done by removing the rod from the gage and catching it by the measuring end in a draw-in chuck in the lathe. A piece of steel was bent to the required shape and clamped to the carriage and a V cut in it at the height of the lathe centers to form a back-rest for the rod. A very narrow, round-nosed tool was then caught in the toolpost with the cutting face vertical, so that when the carriage was moved along the bed of the lathe, the tool, being fed into the rod, planed out a narrow slot. A blunt, thin chisel was then tapped lightly on the beveled edge at the top of the gage body, turning in the edge at one point until it filled the groove cut in the rod. It was then smoothed off so that the rod was a nice sliding fit through it but couldn't turn, the turned-in edge acting as a key.

Anyone having much die sinking to do will find this tool a great improvement over the regular depth gage.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

METHOD OF ATTACHING PUNCHES TO THEIR HOLDERS

In the June number of MACHINERY, under the heading, "Out-of-Date Die-Making Methods," Mr. Shailor calls attention to a blanking punch attached to a punch holder so as to obtain greater rigidity and durability, by saying: "The method illustrated in Fig. 4 is the best that has come under the writer's experience of sixteen years for easily making a rigid, altogether satisfactory punch and die. If any reader knows of a better method we would all like to know of it, and I for one will adopt it."

What I believe to be a still better method of securely holding the odd-shaped blanking punch referred to by Mr. Shailor is shown in Fig. 1. This method is somewhat similar in construction to his except that a slot is planed part way through the punch holder, as shown at *A*, in which the blanking punch is made a driving fit. The round shank *B* is made a driving fit in the hole, and, after hardening, is slightly upset, as shown at *C*, to prevent the punch from pulling out.

In Fig. 2 is shown this same method used in holding two blanking punches in the punch holder. These punches are used in connection with a double blanking die for cutting

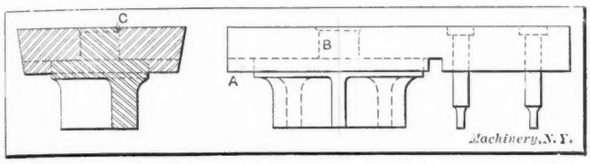


Fig. 1. A Substantial Method of attaching a Punch to a Punch Holder

two blanks at one stroke of the press. In this case the slot is milled through the entire length of the punch holder, as shown at *A*, and the punches driven in and securely held in position in the same manner as that shown in Fig. 1.

The advantage of attaching an irregular-shaped blanking

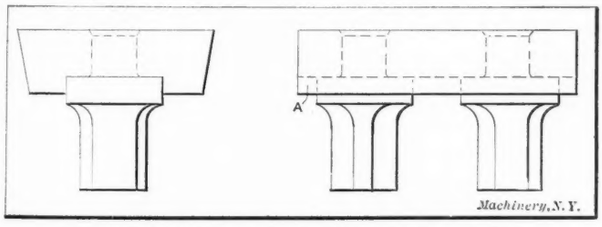


Fig. 2. Punch Holder with Two Blanking Punches attached in a Similar Manner

punch to a punch holder in this manner over the one described by Mr. Shailor, is that it does away with all tapered holes, screws and dowel pins, and forms what may be called a solid or compact mass, which can be depended upon to stand up and hold its own at all times.

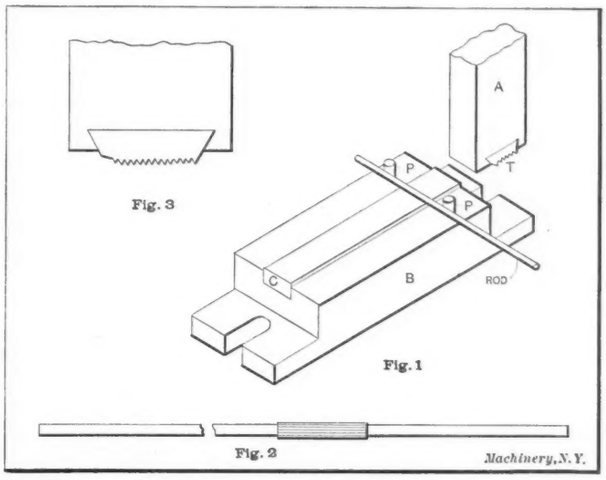
In conclusion, the writer would say that he does not claim that the above is a new or an original method, as it is one that is used by various shops in this city, but, nevertheless, it is one which he considers to be the peer of them all.

Waterbury, Conn. CHARLES DOESCHER

KNURLING IN THE SHAPER

Sometimes those things which at a passing glance appear simple, prove to be the more difficult to solve. This was the case with a few thousand pieces of drill rod which were to have a knurled portion ¾ inch long. The knurling had to be put on to make them a drive fit in a bushing which had a hole 0.108 inch, the same diameter as the rod. This was at first thought to be a good job for the lathe, but experiments proved that even with proper supports a slight kink was developed in many of the rods. It also took considerable time to raise a "burr," owing to the small diameter of the rods.

When knurling in the lathe was found to be unsatisfactory, rolling in the shaper was resorted to, and this was found very satisfactory. A base casting *B*, Fig. 1, having a strip *C* of cold-rolled steel inserted as shown, was used for rolling the rods on, and when it became too rough it was renewed. The base *B* was bolted to the shaper table, by bolts inserted in



Figs. 1, 2 and 3. Details of Knurling Tool and Piece to be knurled

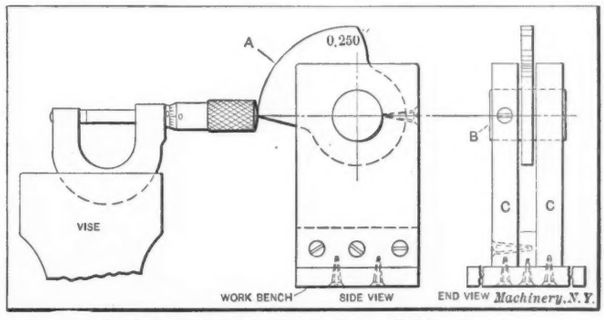
the slots shown. Two stop-pins *P* were also provided for locating the rods at right angles to the stroke of the shaper. A tool-holder *A* carrying a tool-steel die *T*, which had nicks to suit the knurling required on the rods, was clamped in the tool-post in the usual manner. This die *T* is shown enlarged at Fig. 3, and as will be seen, the starting edge is tapered slightly, thus allowing the rods to enter and become confined before any great amount of rolling is done.

In operation, the rods are placed against the stop-pins *P*, and against a longitudinal stop (not shown), while the shaper is completing the rear stroke. The stroke is made long enough so that after passing over the rods there is ample time to take them out before the tool advances. By running at a moderate speed it was possible to turn out a rod for every complete stroke of the shaper, giving an output far in excess of our most sanguine expectations for the lathe method. The rod as it appears when finished is shown at Fig. 2.

Middletown, N. Y. DONALD A. HAMPSON

MEASURING SCREW MACHINE CAMS

In the screw machine department of most shops, there are many screws, pins, etc., made on the Brown & Sharpe automatic screw machine with what are known as "pick-up" cams. These cams are odds and ends of cam sets which are no longer used regularly, and are often used in making small



Device for Measuring Rise on Screw Machine Cams

quantities of screws, when it would be unprofitable to make up a set of cams especially for the job on hand. In order to determine the suitability of a certain cam, it is necessary to measure the travel or throw. This measurement is generally difficult to accomplish. The method most used is for the oper-

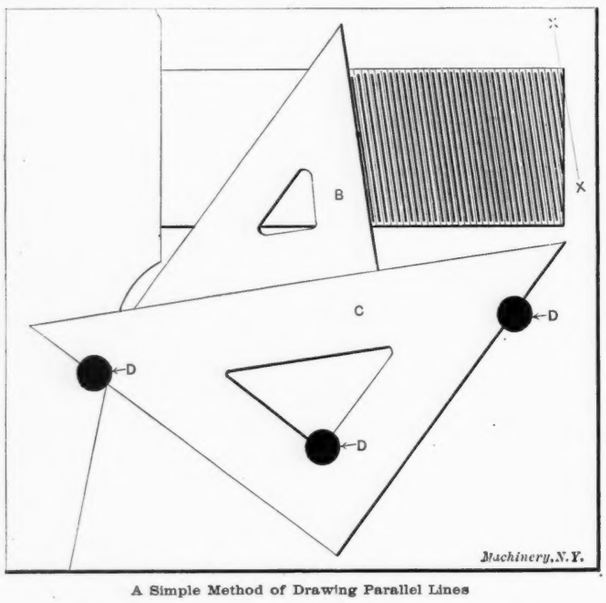
ator to measure with a scale, the distance from the high point of the cam to the center hole, and then subtract the distance from the low point to the center hole, the difference being the travel on the cam. This method takes a great deal of time and patience when hunting through a pile of cams, and often after the job is set up the operator finds the cam selected to be a few thousandths short in travel owing to the inaccurate method of measuring.

The accompanying sketch shows an improved method of measuring cams to thousandths of an inch. *A* is the cam shown placed on the steel shaft *B* held between the wooden supports *C*, which are, in turn, fastened to the work bench. A micrometer is held in the vise as shown, being so placed as to read zero when the end of the barrel touches the high part of the cam lobe. After the cam is revolved the micrometer is adjusted until the end of the barrel is in contact with the lowest point of the cam. The resulting reading will then show the travel of the cam, which is stamped on the face of the cam as shown. DESIGNER

[The method of measuring the rise of cams described in the above no doubt is effective, but is limited to cams having a slight rise. It can be seen that the radius on the head of the micrometer barrel will govern to a large extent the amount of rise that can be measured. Why not stamp the rise on all cams when made and thus avoid the necessity of measuring? Although the practice is not common, it seems to us that the rise should be plainly stamped along with the other data usually put on cams to identify them.—EDITOR.]

METHOD OF DRAWING PARALLEL LINES

Very frequently in making drawings it is necessary to draw a series of parallel lines which are not at such an angle that a thirty-, forty-five-, or sixty-degree triangle can be used in conjunction with an ordinary T-square or parallel straightedge, as would be the case in cross hatching, drawing threads, and similar work, where considerable time is often lost for lack of a simple, quick and inexpensive method of procuring parallelism and accuracy. The method shown in the accompanying engraving has been found by the writer to be very useful in



A Simple Method of Drawing Parallel Lines

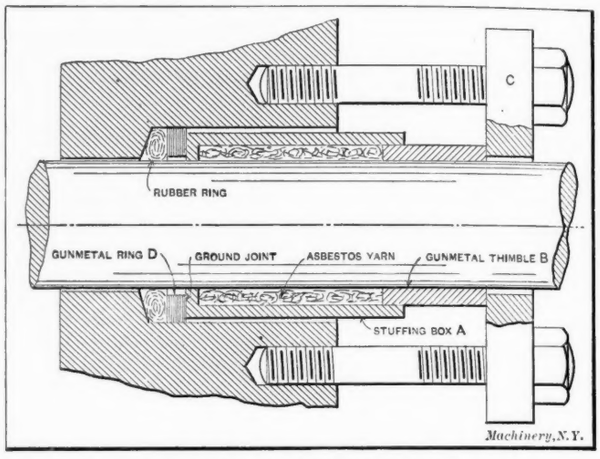
overcoming this difficulty. The line *X-X* is a line drawn at some desired angle, and with which it is desired to draw other lines parallel. To accomplish this, place the triangle *B* with its edge on the line *X-X* and the triangle *C* with one edge against the triangle *B* as shown. Fasten the triangle *C* to the drawing board with thumb tacks *D*. Then by sliding the triangle *B* along the triangle *C* any number of lines may be drawn parallel to the line *X-X*.

This scheme will also be found very useful in making sketches on the road or about the shop where a T-square and drawing board are not at hand. F. B. HAYS

Indianapolis, Ind.

PACKING FOR PISTON-ROD

The piston-rod packing of an engine used in driving a paper-making machine was a constant source of annoyance and trouble. The engine, which was of the horizontal type, had been running twenty-four hours per day for seventeen years without necessitating the reboring of the liner. No doubt the wear on the bottom of the liner and piston caused a certain want of alignment with the guides, thus producing a slight up-and-down movement of the rod, which helped to cause this trouble. It will also be seen from the accompanying illustration that the stuffing-box is very shallow, so that very little packing could be introduced. The constant effort to keep the gland comparatively tight with any packing hitherto tried resulted in heated and scored piston rods. About two years ago



Improved Method of Packing Stuffing-box

the writer designed and applied the device shown in the illustration. Since then this has been running twenty-four hours per day without any attention, except that about a year ago a little additional asbestos yarn was inserted. Steam-tightness is secured with only a very slight tension on the screws, and the rod is smooth and shows scarcely any wear. Before devising this arrangement some form of metallic packing was thought of, but as the steam is very wet it was feared that this might not be successful. A feature of the device is its simplicity and the fact that it can be applied to an engine without any alteration to stuffing-box or gland-studs.

Referring to the illustration: *A* represents the floating stuffing-box made of gunmetal, which is a very loose fit in the old stuffing-box, so as to allow freedom of alignment. The inner flange of this is a sliding fit on the rod. To obtain sufficient strength in the walls of the box, only ¼ inch was left all around for the packing, which was asbestos yarn rubbed with graphite. A gunmetal thimble *B*, which is a sliding fit on the rod and also in the stuffing-box, compresses the packing when pressed forward by screwing up the gland nuts. *C* is a cast-iron plate bearing on the end of the thimble, with the central hole large enough to clear the rod. A gunmetal ring, *D*, which is drilled to clear the piston-rod, rests on a ring of ⅜-inch round rubber placed in the bottom of the old box. The faces of the ring and the new box, which are in contact, are carefully faced true, and afterward ground together to make a steam-tight joint. JOHN PEDDIE

Southland, New Zealand.

PRINTING THROUGH THICK DRAWING PAPER

A man working in a drafting-room is sometimes called upon to make blueprints from drawings that are inked on heavy paper, such as patent office drawings. Now, if a print is made in the usual way, by putting the paper face down in the printing frame, placing the blueprint paper on top and printing through it, the thick paper separates the inked lines from the blue paper and allows diffused light to get under and blur the print.

Now, if the paper is turned over so that the inked lines come in contact with the blueprint paper, it makes a good

print, but it will be a negative. However, if thin blueprint paper is used and the back of that put next to the inked lines, you only have the thin paper between the inked lines and the chemical surface, so that a good print is made, which will be a positive. AUSTIN G. JOHNSON

Two Harbors, Minn.

EXPANSION MANDREL FOR TURNING CONES

We had a large number of four-step cones to turn up on the lathe, and in order to save time and expense, I made them in the following manner:

The diameter of the steps were 4½, 6, 7 and 9 inches, respectively. The bore was 1⅛ inch, and the bearing 4 inches long, which leaves the two larger steps without any support, as shown at *A* in Fig. 1. This made it difficult to turn them up without bending the mandrel. An expansion disk, as shown at *B* in Fig. 1, was made. This disk had six slots,

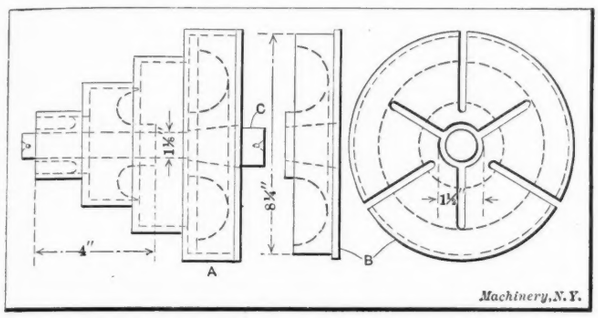


Fig. 1. Details of Expansion Mandrel and Disk for Turning Cones

three extending to the edge. The hole was bored, and tapered ⅝ inch to the foot, the largest diameter being 1½ inch. The outside diameter of the disk was turned to fit the inside of the largest step of the cone. A mandrel was then made, as shown at *C*, and turned to fit the bore of the cone and the taper in the disk. By driving this mandrel into the disk, it expands and grips the inside of the large step, which makes it easy to turn the cones. The mandrel has a feather peened in the tapered part, as shown at *A*, in Fig. 2, which fits one of the three slots in the disk. In this way the mandrel has no chance of slipping in the cone. By using this expansion disk, about twice as many cones were turned out in a day as by using a common 1⅛-inch mandrel, and it also saved the expense of making and straightening so many mandrels. This

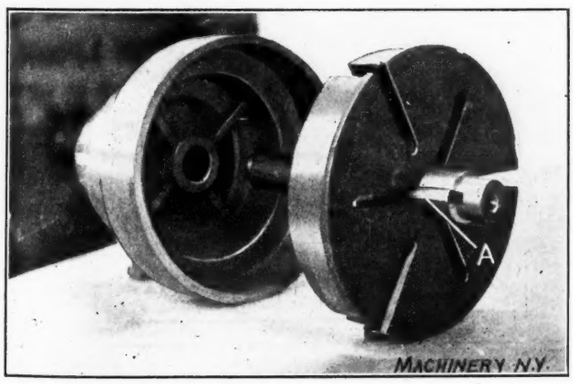


Fig. 2. View showing Manner in which the Disk is expanded

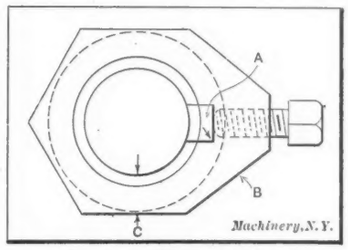
expansion mandrel allowed us to use a much higher speed and feed than was possible by using a 1⅛-inch mandrel.

Salem, Ohio. L. J. GETZ

AN EFFICIENT LOCK NUT

Having seen from time to time a great variety of lock nuts described in MACHINERY, I wish to add one more to the collection, which I believe to be new to many designers. It is one which has been successfully used, and has never been known to let go or work loose. The way in which this nut is made is as follows:

The key (or feather) *A* is fitted into the nut before it is bored to the finished size or threaded. After the key is inserted the nut is bored to the finished size and tapped, which also cuts a thread in the key, so that when it is screwed onto the shaft and the set-screw is tightened, it will not bruise the thread. When designing this nut it is advisable to make the part indicated at *B* as thick as the part indicated at *C*. A special wrench is generally made for this nut, but where one is not at hand an ordinary wrench can be used. H. E. WOOD



A Simple and Effective Lock Nut

Newark, N. J.

HEIGHT GAGES FOR INSPECTING

Some years ago I made two gages for testing milling fixtures and drill jigs having working faces and bushing holes in such places that it was impossible to measure with the ordinary height gages in use. The two gages were used in conjunction with each other—that is, the testing gage shown in Fig. 1 was used on the work, and the measurement recorded on the gage shown in Fig. 2. The long arm with the multiplying levers on the testing gage (Fig. 1) is brought into contact with the surface or hole to be inspected, and by adjusting the nut *C* a proper reading at *B* is noted. This arm is now brought into contact with one of the steps *A* on

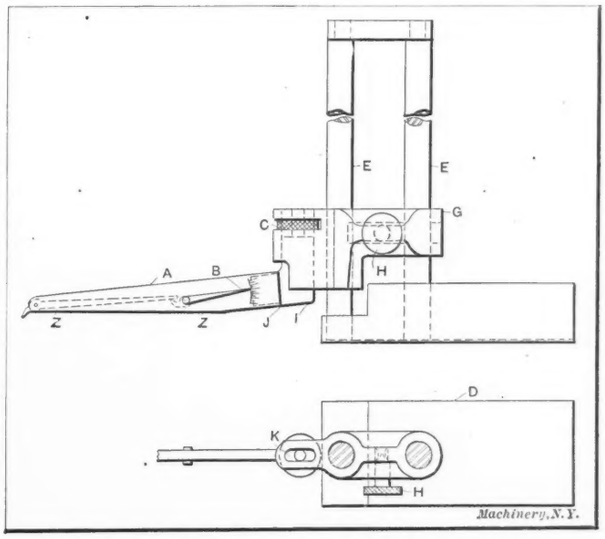


Fig. 1. Testing Gage used in taking Measurements

the recording gage (Fig. 2), and the barrel *B*, which was previously set to zero, is now turned until the testing gage registers the same as on the work. The reading which is noted will give the height from the base of the recording gage.

The testing gage shown in Fig. 1 consists of a tool-steel base *D* having two shafts *E* fastened to it and connected at the top by a link. On these shafts the sliding member *G* is operated, and can be locked securely in any position by means of locking screw *H*, which acts upon two clamping bolts. This method of clamping obviates all springing and is positive.

The adjusting nut *C* operates the part *I*, which is carefully fitted in the slot. On this same part is a shoulder at *J*, to which is fastened the arm *A*. This arm is made from tubing and formed similar to the opening at *K*. The part *A* is made a tight fit at *J* on the part *I*, and a pin put through to fasten it securely. This oblong tube *A* is now cut along the line *Z*, *Z*, and inside of it are placed the levers which are arranged to

give a reading of one-half thousandth of an inch. This gage has a wide working range, and can be applied in some very small places. Its usefulness as an accurate testing instrument has convinced the writer and others that it is a valuable addition to the tool-room equipment.

The recording gage shown in Fig. 2 is made accurate and tested thoroughly. The base *C* is of tool steel, having a stud *E* driven in perfectly square with the base. On this stud a sliding member *D* is operated by means of the barrel *B*. A good fit must be made at *f*, *f* to insure against lost motion when turning *B*. The hub end of *D* is provided with an internal thread, which is 40 threads per inch, to fit the threaded part on the barrel *B*. This hub is split and a threaded ring *P* is fitted on the outside, which is also threaded and slightly tapered, so that proper adjustment can be made for back lash

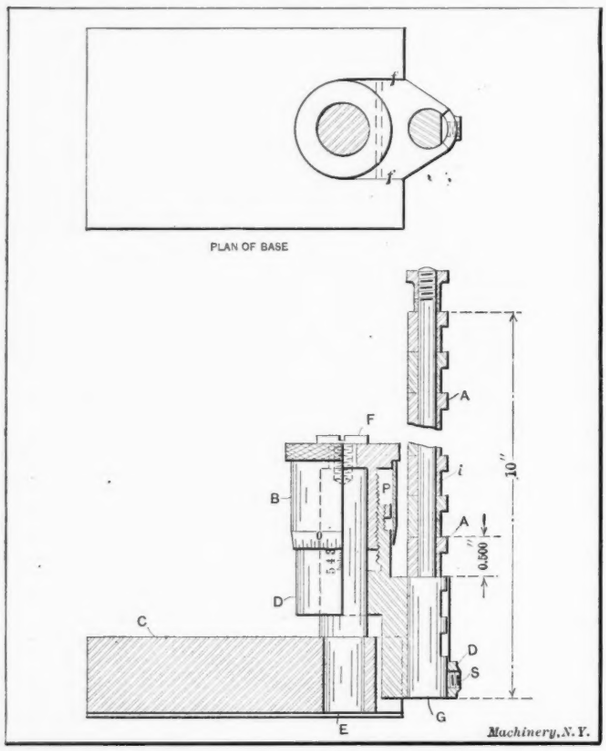


Fig. 2. Gage on which Measurements as taken by Testing Gage are recorded

in the thread. The stud *E* is of tool steel, hardened and ground, as is also screw *F*. The shaft *G* is also hardened and ground, and the steps or bushings *A* are made as accurately as possible, the length being exactly one-half inch. Provision is made at *i* so that the pointer on the testing gage can rest properly on the ledge. The shaft *G* is fastened to *D* by means of set-screw *S*. In assembling the shaft and bushings care should be exercised in tightening the nuts so as not to spring them.

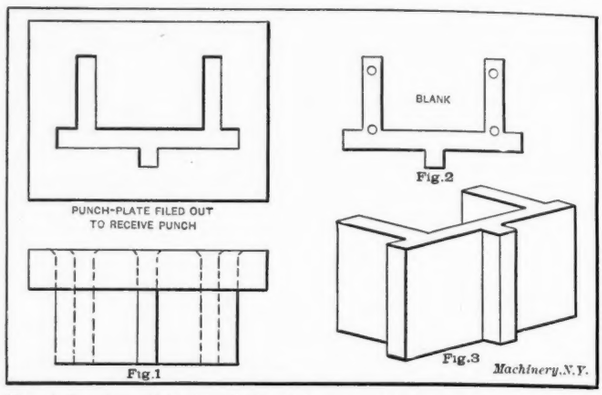
A. C. LINDHOLM

New Haven, Conn.

REMARKS ON OUT-OF-DATE DIE-MAKING METHODS

I have read with much interest the article on "Out-of-Date Die-Making Methods" by F. E. Shailor, in the June number of MACHINERY, and while I agree in general with his conclusions, I think he is unduly severe in his criticism of the two particular methods of securing the blanking punch to the punch plate, which he has singled out for attack, and which he calls "out-of-date methods."

It is quite true as Mr. Shailor says, that these methods are still in use in "some large (up-to-date) ? factories," and I prefer to believe that there are reasons for this, other than that of ignorance of what Mr. Shailor calls "an improved method." In fact, I have seen both methods used at the same time in the same shop, with honors about even. For the sake of distinction, we will call the method shown in Figs. 1, 2 and 3 the "old method" and that shown in Fig. 4, the "new method." Let us first look at the objections raised to the "old method." The first objection raised is the difficulty of filing out the punch plate to fit the punch exactly. In speaking of this, Mr. Shailor says, "We know that a plug and ring gage will 'shake' if there is a difference of 0.0001 inch. Can we expect to file perfectly straight and within one-tenth



Figs. 1, 2 and 3. Objectionable Method of Attaching Punch to Plate (Taken from "Out-of-Date Die-Making Methods," by F. E. Shailor, in the June issue)

of a thousandth?" In this, Mr. Shailor has let his zeal get the better of him. If it is true that one-tenth of a thousandth inch too small will make a plug and ring gage "shake," it is also true that one-tenth of a thousandth inch the other way will make a tight fit, so that the argument works both ways. But it is not necessary to file this style of punch plate either perfectly straight or to a "tenth of a thousandth," for the hole in the punch plate may be made slightly tapered and sufficient material left on the punch-plate end of the punch to make a tapered fit, and the punch may be driven or pressed home after the working end has been hardened; after which it may be riveted over into the countersunk edges of the punch plate and planed off flush with the plate. In this way a fit may be secured which will be of equal rigidity to the "new method." If anyone will take the trouble to calculate the area of the bearing surfaces which come in contact with the

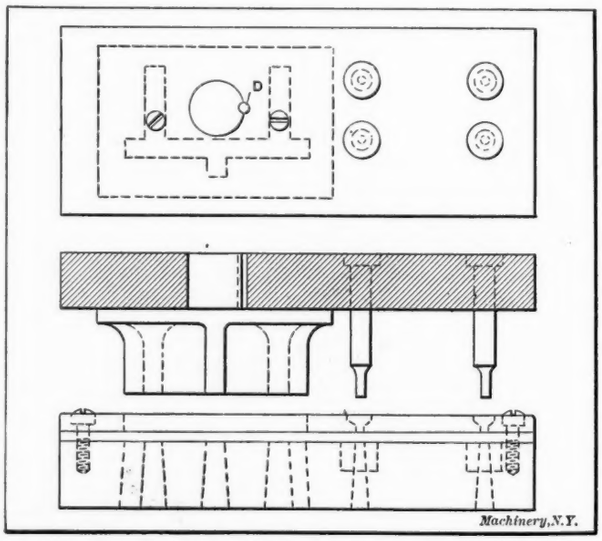


Fig. 4. Punch Attached to Holder so as to obtain Greater Rigidity and Durability (Taken from "Out-of-Date Die-Making Methods," by F. E. Shailor, in the June issue)

punch plate in this inserted method of holding the punch, I think they will find that it is equal to the area of the average base used with the "new method."

One advantage which the "old method" has over the "new method" is the ease with which the punch may be machined. With the "old method," the punch may be held in the jaws of the shaper or milling-machine vise and milled or shaped across the entire length of the punch. This is quite a consideration in small shops where there is no milling machine; but even where there is the full equipment, the "old method" punch is easier to machine than the "new method"

punch, which has to be worked out on the milling machine with end mills and various shaped cutters, after which it is necessary to use the point of your file on account of the radius left by the milling cutter.

Another great advantage of the "old method" is that the punch has more wearing surface. The working part of the punch extends close up to the punch plate so that the punch can be used until it has become so short, that the punch plate strikes the stripper before the punch engages the die. This cannot be done with the "new method," owing to the space taken up by the base and radius of milling cutter.

Still another advantage of the "old method" is that the punch can be made short to obtain greater rigidity and still have as much wearing surface as a much longer punch made by the "new method." This is a great advantage where very small piercing punches are used with the blanking punch, because the piercing punches may be made shorter also, and therefore more rigid and less likely to break.

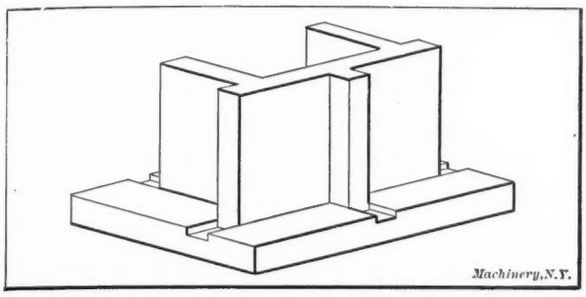


Fig. 6. Another Objectionable Method of Attaching Punch to Plate. (Taken from "Out-of-Date Die-making Methods," by F. E Shailor, in the June issue

We fail to see any difficulty in transferring the holes for the piercing punches from the die to the punch plate. To turn the die upside down on the punch plate and use the piercing die as a drill jig is a sure way to invite trouble, and is certainly an out-of-date method. It is not necessary to do it in this way. A much better way is to first transfer the dowel pin holes (used to hold the die in position on the die block) from the die to stripper and punch plate. Next place the die on the faceplate of a lathe, clamp lightly, and indicate the hole to be transferred with a center indicator, and then clamp it tightly. Next place the dowels in the holes and then place the punch plate on the dowels, with the punch inserted in the die, and clamp it on parallels sufficiently high to prevent the punch plate from coming in contact with the clamps holding the die. Now drill and bore the hole in the punch plate and it will be found exactly in line with the indicated hole in the die. Then remove the punch plate, leaving the die set as before, place the stripper on the dowels in the same manner, and drill the same sized hole through the stripper. Next remove the stripper and move the die so as to bring another hole central; get it running perfectly true and then transfer to stripper and punch plate as before. Continue this process until all the holes have been transferred, and you will have a die that will be in perfect alignment and it will not be necessary to knock over any of the piercing punches.

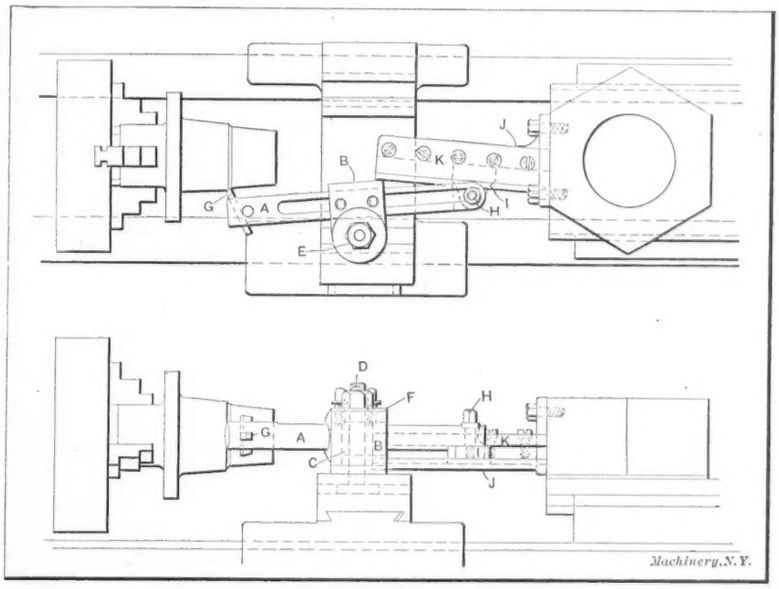
Fig. 6 in Mr. Shailor's article is styled "another objectionable method of attaching the punch to the punch plate." A punch is shown, set in grooves in the punch plate and presumably fastened by screws through the plate. Your readers are asked to imagine a punch one inch long and one-half inch wide, made in this way. Now, we are ready to admit that a punch of those dimensions would be a complete failure if attached to the punch plate by the method objected to; but this does not prove that the method is without merit. It only proves that it is not the proper method to use in this particular case. Suppose, on the other hand, the punch was one inch long and two inches wide, would not the weight of the "insufficient base" argument be somewhat decreased? A punch of these dimensions would have ample base without going to all the trouble of machining your punch so as to form a base. If all punches were made one-half inch wide and one inch long, then Mr. Shailor's argument would hold good, but of course that is not the case; therefore the argument fails. Then look at the simplicity of this so-called "objectionable method." See how easily the punch can be machined and how quickly, and therefore cheaply, it can be fastened to the plate, and above all notice the greater length of wearing surface, when this method is used, than can be obtained by the so-called "improved" method. We have then in this "objectionable" method the following advantages: simplicity, cheapness and maximum length of the working part of the punch. Surely these are things to be considered in the choice of a method of making a punch. The fact that punches made in this way have been relegated to the scrap heap by some manufacturers does not prove that they are without merit. It only proves that another method has been found to be better adapted to their particular class of work.

The writer's private judgment is, that no fixed rule can be laid down, but that one must be guided by circumstances. He should adapt his method to the class of work to be done and should consider the character and quality of the work to be done, the quantity to be done, and the cost of making the tool. I believe it is this fixed method idea of making punches and dies that oftentimes runs the cost up so high, and causes a great deal of trouble in the press-room.

In conclusion, let me say that in these days when so many thousands of minds are concentrated upon the problems of punch and die work it is, to my mind, impossible with any degree of certainty to decide who is the originator of any particular method, unless it is a patented method or process. To say that this or that method originated at any particular place is equal to saying, "I know the methods used by every maker of punches and dies in the world. Therefore I know that this method originated with Mr. So and So." I sincerely hope that these criticisms will be taken in the spirit in which they are given.

WILLIAM BROWN

Frankford, Pa.



Elevation and Plan of a Taper-turning Attachment for Turret Lathes

SPECIAL TAPER-TURNING ATTACHMENT

A large number of valve bodies for gas engines had to be bored and turned, and the job could be done economically on a turret lathe, with the exception of the outside taper. As there was no taper attachment on the machine, it looked at first as if the taper turning would necessitate a separate operation in a center lathe, and consequent increase of cost. The outcome of some consideration of the subject is shown in the

accompanying sketch, which illustrates the attachment for turning the taper in the turret lathe. It might be well to mention that the taper was not an important one, it being done merely to give a finished appearance to the engines.

The device consists of a bar *A*, 1¾ inch in diameter, held by set-screws in the desired position in the steel holder *B*, which swivels upon the steel bushing *C*. This bushing is bored to fit the bolt *D* which holds it firmly in place, and it is made of sufficient length to allow the holder *B* to swivel without shake when nut *E* is screwed tight.

The turning tool *G* is held at one end of the bar, and the other end is flattened and drilled to receive the coller screw *H*, which attaches it to the guide-block *I*.

Attached to the face of the turret is a casting *J* having a groove in it which is at about the same angle to the turret face as the taper it is desired to turn. Into this groove fits a tongue on the guide-block *I*, and the top plate *K*, fastened by five screws, forms a slide along which the guide-block moves when the carriage is fed along the lathe bed (the turret being fixed) thus causing the tool *G* to recede from the work as it is being fed towards the chuck. The requisite adjustment of taper is obtained by altering the distance between the cutting tool and the swiveling block; that is, by loosening the set-screws and sliding the bar farther out or in, a taper is obtained more or less steep according to requirements.

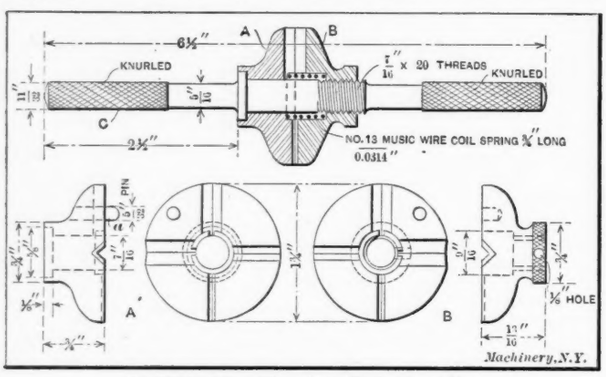
The other five faces of the turret are, of course, set up with tools for the boring operations. The device is detached from the tool-slide for every valve body machined, by loosening the nut *E* and removing the screw *H*.

This device does the work in a very satisfactory manner and has now been in use for some years. G. H. GIBBS

Loughborough, England.

A TOOLMAKER'S TAP WRENCH

The accompanying illustration shows a very useful and efficient tap wrench for tapping holes varying from 1/16 to 3/8 inch in diameter. This wrench is especially adapted for tapping very small holes, as it is not necessary to apply any pressure to force the tap into the work on account of the weight of the segmental holders *A* and *B*. All that is necessary when tapping a small hole is to grip the knurled ends of the handle



An Efficient Tap Wrench for Toolmakers' Use

C lightly in the fingers, keeping the tap vertical and turning it slowly.

To give good results, this tap wrench should be made so that it will balance when tapping; and when made in this manner it will be found to be very efficient for small and delicate work especially. The holders *A* and *B* have four grooves in each, which when brought together form squares varying from 1/16 to ¼ inch; where a greater range of holes is necessary, six or more grooves may be cut in each segment to suit the requirements. The segment *A* is held in the correct location with *B* by the pin *a*. A small coil spring is inserted as shown, which keeps the part *A* up against the shoulder and also tends to separate the two segments, facilitating the insertion of the tap.

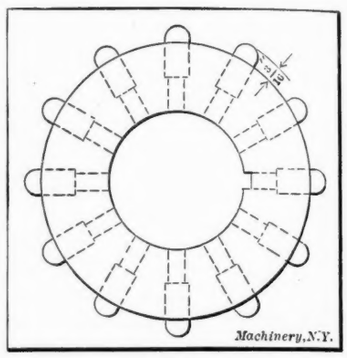
This holder can also be used as a small hand chuck for holding drills when drilling in the lathe, as the grooves are diametrically opposite, enabling one hole in the wrench to be placed on the center of the lathe similar to an ordinary hand chuck. A small 1/8-inch hole is drilled in the part *B* so that it may be screwed up to hold the drill firmly.

The segmental holders are made from tool steel, as is also the handle *C*. The parts *A* and *B* should preferably be hardened to prevent wear. The proportions given in the engraving will be found ample for taps varying from the smallest size up to 3/8 inch. G. MURRAY

WHAT IS MODERN PRACTICE?

In the July number of MACHINERY, L. Rosenthal asks "What is modern practice?" I am afraid that if we should ask a number of machine shop foremen this question, we would get a different answer from each of them. For my part, I would like to have these men send in their answers, as this is a very interesting question.

"Modern practice" as far as the machine shop is concerned, is the doing away of all hand work as far as possible, and by doing the work on machines, using high-speed steel cutting tools, and seeing that the proper speeds and feeds are used in the manufacturing department and toolroom. I might add that machine operators are taking the place of the toolmaker at the machine, leaving him to do what hand or bench work is required, and which cannot be done otherwise. These machine operators doing the machine work cheapen the job, and, being constantly at one machine, they become very proficient.



Modern Method of Making Male Embossing Rollers

We all know that hand work is slow, and if the work must be accurate we might have to put a first-class toolmaker on the job, thereby increasing the cost. To make my point clear, let us take the two rolls which Mr. Rosenthal made, and do away with the time he spent laying out the holes in the female roll, and laying out and filing the projections on the male roll, and see if by omitting all the hand work, we cannot give the customer as good a job and at less cost, and at the same time, prove out my answer as to "what is modern practice."

Referring to the illustration in Mr. Rosenthal's article, it will be seen that the male roll was made solid and that all the projections were first made square by removing the superfluous material between them in the shaper, and then filing them to shape. Now, the filing took considerable time, and if we can get away from this, we will accomplish the job in a modern way.

To proceed with the modern method we will first give the stock to a lathe hand who will bore the hole, face, and turn the outside diameter of the two blanks, making them both the same size. Then we will give the rolls to the milling machine hand, who, putting the male roll on an arbor, will set it on the centers, using the dividing head to space and drill each hole to the same depth, making the holes a driving fit for the drill rod pins, which have been formed on one end and cut off 3/16 inch plus the depth of the hole in the roll. This roll will have at least one advantage over Mr. Rosenthal's, because if one or more of the pins should break, we could drive the broken pin out and replace it without annealing the roll, as is clearly shown in the accompanying illustration. The blanks are now ready for hardening, after which an apprentice can assemble the pins and hand the job in as finished.

I have worked in several shops and have met the "old timer" with his "old-time" ways of doing certain jobs, and being a "modern practice" school graduate myself I have found their ways very interesting though slow. In my opinion "modern practice" is doing away with as much hand work as possible, and having machine operators do the machining.

Harrisburg, Pa. E. L. PICKERING

PLATE FOR INDEXING IN DEGREES

At one time it became necessary to affix an indexing plate to one of our machines so as to be able to set a pointer at any one of the 360 degrees of a circle. The ratchet *A* was not large enough to allow cutting 360 teeth in it, as these teeth had to withstand a moderate straining due to a flat coiled spring not shown in the illustration. Accordingly 120 divisions were provided in the ratchet and the pawls *B* were made so that they differed in length by 1/3 the distance between two of the ratchet teeth, or in other words by 1/3 the pitch of the teeth. The action of the pawls is, therefore, consecutive; No. 1 first engages the ratchet, then if the pointer is moved 1/360 of a revolution, or one degree, No. 2 engages and so on. The pawls are kept in engagement with the ratchet by means of the flat steel springs *S*, as shown. The whole fixture is supported on the plate *F*, which is part of the machine.

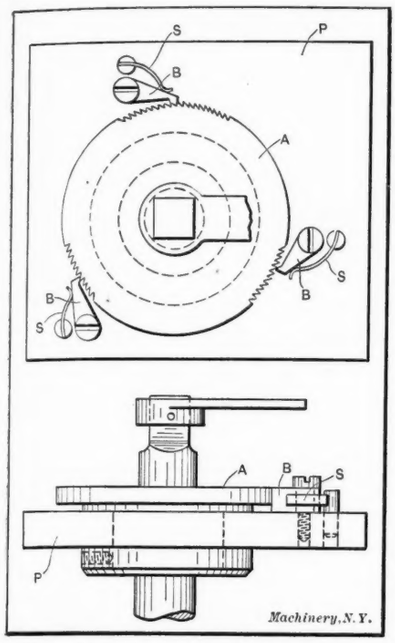
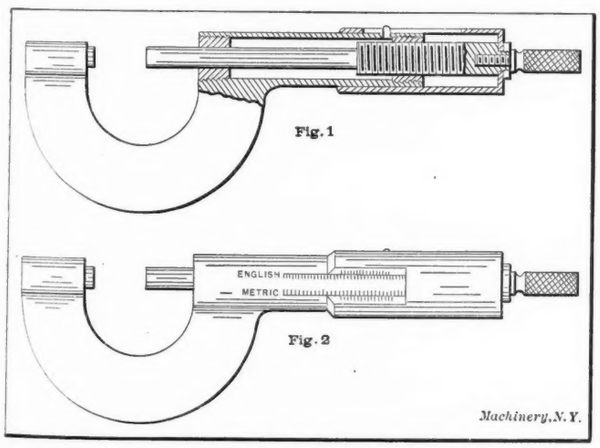


Plate which, by the Aid of Pawls of Unequal Lengths, indexes to Degrees

F. B.

MICROMETER FOR READING DIRECTLY VARIOUS SYSTEMS OF MEASUREMENT

Mechanics have doubtless often realized the need of some precise measuring tool that would show various systems of measurement in their relation to each other, so that English measurement could be converted to metric, fractional parts to decimal parts, wire gages or rolling mill gages to parts of an inch or millimeter, drill gage sizes to fractional or decimal parts of an inch or millimeter, or, in brief, any desired system of measurement in proper relation to any other. Of course, the caliper square fulfills to a limited degree such a requirement, as some of these tools are so graduated that either English or metric measurements may be read directly. To make it possible to read various systems of measurement, I designed the universal sliding micrometer shown in the engraving.



Figs. 1 and 2. Universal Sliding Micrometer which may be graduated with Various Systems of Measurement

This micrometer is designed along the principle of the ordinary micrometer in combination with a sliding caliper. It consists, as may be seen in the sectional view Fig. 1, of a body and barrel, a sleeve, and an operating screw. The action of the measuring bar is practically the same as with the ordinary micrometer, but the sleeve of this tool, instead of rotating, slides along the barrel, any rotary movement being prevented by a small pin which engages a longitudinal guide slot that is parallel to the axis of the screw. This sleeve has a concentric bore at its end, which fits a shoulder on the screw body and it is held in place by a nut that is adjusted so as to permit a free rotation of the screw in the sleeve without any play. It will thus be seen that by operating the screw, a longitudinal motion is imparted to the sleeve. It is therefore immaterial what the pitch of the screw is, as in this case it serves simply to move the sleeve along with it. The position of the micrometer spindle with relation to the anvil, is determined by a scale on the barrel and a vernier scale on the sleeve, as illustrated in Fig. 2. Thus the barrel serves the same purpose as the beam of the caliper square and the sleeve acts as a vernier scale. It will be seen that this construction allows the micrometer to be designed for measuring according to a number of different systems, which are shown in their correct relation to each other. The zero mark, of course, coincides for each system of graduation on the micrometer, and the barrel can be made of any suitable diameter to permit the easy reading of the graduations.

MAX MUNZNER

Newark, N. J.

SIMPLE TABLES FOR CALCULATING CIRCUMFERENCES AND AREAS OF CIRCLES

The simple tables given herewith may be used for calculating the circumference and area of circles without multiplication. The first table for the circumference of circles gives the value of π for diameters from 1 to 9 inclusive. To use the tables for larger numbers, proceed as follows: Suppose the circumference of a circle 32 inches in diameter is required: Change the decimal point of 9.4248 one place to the right and underneath write the value of 2 taken from the same column. The sum, or 100.531, is the circumference for a circle 32 inches in diameter. In the same way, the circumference of smaller or larger diameters can be obtained by simply changing the position of the decimal to the left or right according to the number of places. In the case of a number having four places, four numbers will be obtained to be added. Example: Find the circumference of a circle 3,486 feet diameter.

Circumference for diameter.....	3,000 = 9424.8
Circumference for diameter.....	400 = 1256.4
Circumference for diameter.....	80 = 251.3
Circumference for diameter.....	6 = 18.8
	10951.3

The table for finding the areas of circles is used in the same manner except that the diameter of the circle must first be squared and then the areas taken from the table and added as directed for obtaining the circumferences. Example: $12^2 = 144$.

Area for diameter.....	100 = 78.54
Area for diameter.....	40 = 31.416
Area for diameter.....	4 = 3.1416
	113.0976

Circumferences of Circles

$1\pi = 3.1416$	$6\pi = 18.8496$
$2\pi = 6.2832$	$7\pi = 21.9912$
$3\pi = 9.4248$	$8\pi = 25.1328$
$4\pi = 12.5664$	$9\pi = 28.2744$
$5\pi = 15.7080$	

Areas of Circles

Area diameter.... 1 = 0.7854	Area diameter.... 6 = 4.7124
Area diameter.... 2 = 1.5708	Area diameter.... 7 = 5.4978
Area diameter.... 3 = 2.3562	Area diameter.... 8 = 6.2832
Area diameter.... 4 = 3.1416	Area diameter.... 9 = 7.0686
Area diameter.... 5 = 3.9270	

Roxbury, Mass. LOUIS F. LANG.

[The same expedient may be profitably employed for transforming English and metric measures.—EDITOR.]

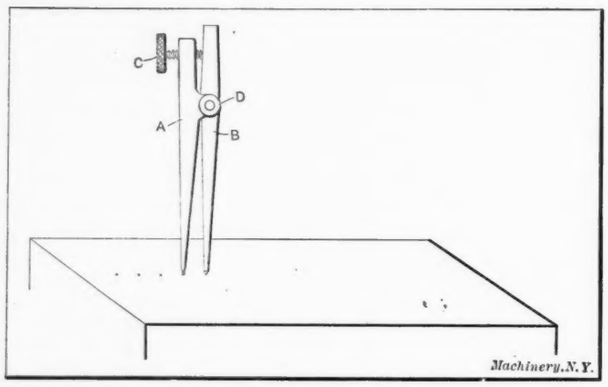
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

COMBINATION DIVIDER AND PRICK-PUNCH

A handy combination divider and prick-punch for laying out evenly-spaced holes on a die or similar work, is illustrated herewith. A divider leg *A* and a prick-punch *B* are combined. These may be adjusted by the screw *C*, and clamped by the nut



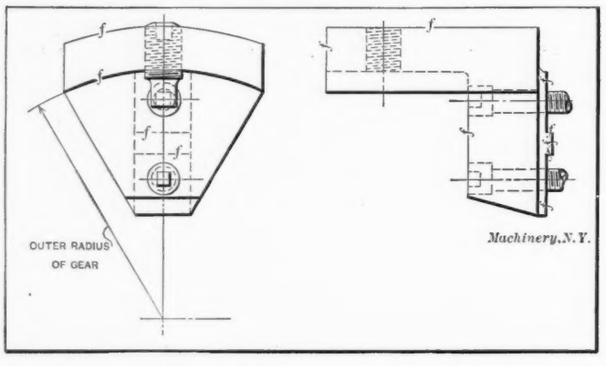
D. Obviously, only a light hammer blow should be used on this tool as it is intended for merely laying out holes accurately. The marks should afterward be enlarged by a heavier prick-punch. This tool might be improved by the addition of a spring hammer attachment similar to that used on a B. & S. prick-punch.

CHARLES WESLOW

Buffalo, N. Y.

CHUCK JAWS FOR GEARS

The accompanying engraving shows two views of a chuck jaw that has proved very satisfactory for heavy turret lathes. It is sometimes hard to hold large cast gears while boring, facing and turning the hubs in a heavy turret lathe, but by using this design of jaw I find that large cast gears can be machined with good results. These jaws are attached to the plain jaws of a three-jawed chuck by screws. One jaw is fitted



with a large screw as shown, which acts as a driver, by engaging a tooth space. The broad face with a radius to fit the outside of the gear teeth insures the gears being bored true in relation to the teeth, and at the same time provides a method for securely holding heavy work.

JIG AND TOOL DESIGNER

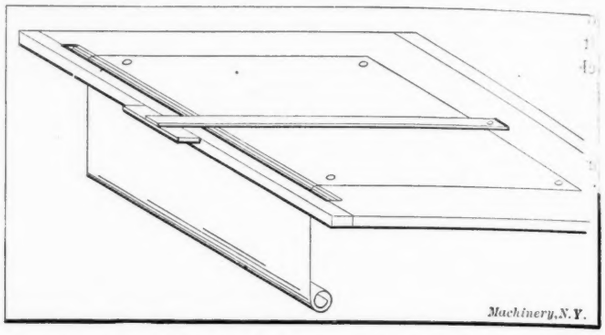
PREVENTING TRACINGS FROM STRETCHING

Every draftsman is more or less familiar with the tendency of tracing cloth to stretch and wrinkle, especially on damp days. The common method of working in one direction on the tracing and taking up the slack from time to time does not always prove satisfactory. To obviate this the following method was adopted: A couple of ordinary incandescent lamps with shades attached were hung over the drawing, the heat generated keeping the cloth in fine shape, and by moving the lamps from place to place over the drawings, the job was accomplished with less trouble than formerly.

F. B.

DRAWING-BOARD FOR LARGE DRAWINGS

As there were a lot of long drawings to be made and no large board or T-square handy, some scheme had to be devised for working on them. I removed one strip from the side of a board that happened to be a castaway, and cut out a space that would allow the drawing to pass between the strip and the board proper. The upper corner or edge of this notched part was then rounded so that the tracings would not be

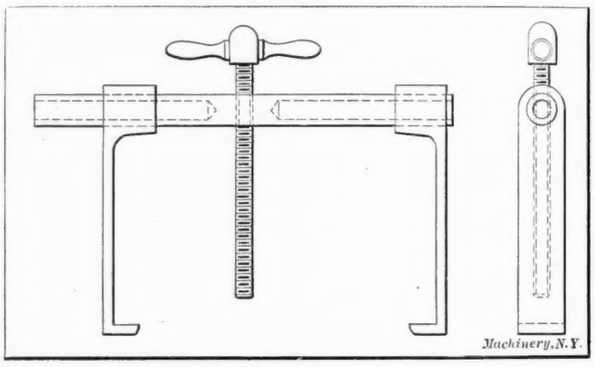


creased. The strip was then re-nailed in place, thus making a board similar to the one shown in the illustration, which became the most useful board we had.

Wilkinsburg, Pa. D. F. HUDDLE, JR.

DIEMAKERS' CLAMP

The accompanying illustration shows a clamp which was made by Leo Hill of Sargent & Co., New Haven, Conn. This clamp was made from a piece of cold-rolled stock with holes drilled in each end to lighten it. The two clamping strips



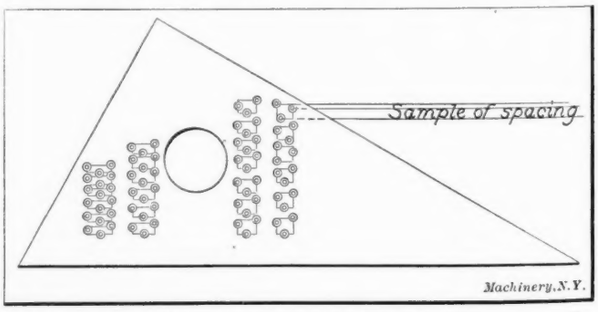
are made a good sliding fit on the rod and can be adjusted to the distance required. This clamp has been found very efficient for diemakers' use.

JAMES FRASER

Marshallton, Del.

LETTERING TRIANGLE

A sixty-degree lettering triangle is shown in the accompanying illustration, which is provided with a number of taper holes in groups of three each, that are used for drawing guide lines of different types for lettering. When guide lines are to be drawn, the pencil point is inserted successively into each of the three holes of a group which are spaced to the required



height, and the triangle is moved along the T-square. By having these holes tapering, it is easier to insert the pencil point in them and the pencil can also be inclined at a considerable angle without danger of breaking the point.

Braddock, Pa. A. C. COCHRAN

SHOP RECEIPTS AND FORMULAS

A DEPARTMENT FOR USEFUL MIXTURES

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

LUBRICANT FOR SMALL OIL-STONES

As a lubricant to use on an oil-stone, for honing-out dies or other similar work, kerosene oil gives the best results as it not only enables the stone to "take hold," but also keeps it clean and prevents it from filling up. C. F. EMERSON

TO REMOVE DRIED OIL

To remove dried or gummed oil from finished machine surfaces, try the paint and varnish removers sold by the painters' supply stores. They work admirably, if applied with a stiff brush, dissolving the hardened oil easily.

Norwich, Conn. GEORGE W. ARMSTRONG

TO WATERPROOF CEMENT

To waterproof cement, apply a finishing coat of cement mixed with sour milk to the consistency of paint. The curd of the milk fills the interstices of the cement making it proof against water seepage. Certain colloids or clays also may be used with success. M. E. CANEK

INCREASING DURABILITY OF WELL-PLUNGER LEATHERS

The durability of the leather cups that are used on deep well plungers as packing, is greatly increased if they are dipped in hot paraffine before being used. When treated in this manner they do not harden and crack as soon as otherwise. JOHN B. SPERRY

Aurora, Ill.

OXIDE OF LEAD AS A LUBRICANT

The best lubricant for lathe and grinder centers is a mixture of powdered red lead (oxide of lead) and lard oil. When using this lubricant, if the oil dries out the centers do not cut, but simply take on a high polish. This mixture also works well for thread cutting, and a much smoother thread can be cut in tool steel than with plain lard oil. JOHN B. SPERRY

Aurora, Ill.

WORN MACHINERY OIL SUBSTITUTE FOR LARD OIL

In a parsimoniously conducted shop, the management refused to furnish lard oil for cutting purposes. The men discovered an efficacious substitute in the machinery oil that had been through the line-shaft bearings. The old oil which was removed from the drip cups, proved an excellent lubricant for threading, etc. GEO. W. ARMSTRONG

Norwich, Conn.

VALVE GRINDING MIXTURE

The following mixture will be found very good for the grinding of valves in gasoline and steam engines or for those used on steam, gas or water pipes. Take one pound of vaseline and into it thoroughly mix about two tablespoonfuls of the number of emery that is to be used. Care should be taken to have the proportion of emery to vaseline the same as that given, as too much emery does not work so well.

Indianapolis, Ind. J. B. KEMP

COMPOUND FOR LEAKY PIPE CONNECTIONS

In automobile work it is often difficult to keep intake pipes, carburetors or water connections from leaking. In cases where a paper gasket has been used, the following compound will be found very good, as it will stop all leaks and make the use of the paper gasket unnecessary. Into one pint of shellac thoroughly mix three tablespoonfuls of dry red lead in powder form. If the shellac seems too thin after the red lead is mixed into it, leave the contents exposed to the air until of the desired consistency. J. B. KEMP

Indianapolis, Ind.

ANNEALING NOVO STEEL

In annealing some Novo steel cutters I heated them to a white heat and buried them in charcoal, but on trying to recut the cutters I found them to be very hard, being almost as hard in fact as before annealing. The job was put aside and later it was turned over to another workman who annealed them as follows: The cutters were heated to a yellow heat and then cooled to a dull red, when they were rubbed with yellow laundry soap until they were cold, when they were found to be thoroughly annealed. W. C. BETZ

New Britain, Conn.

LUBRICANT FOR LOW TEMPERATURES

Because of the congealing or thickening of the greases customarily used, the oiling of machinery, particularly that used in unwarmed places, is in winter sometimes difficult. Oils thinned with kerosene do not readily thicken or congeal. A combination of cylinder oil, kerosene, and graphite will stand a temperature several degrees below zero without losing its capacity for flowing freely. The cylinder oil and graphite should be mixed to the consistency of a thin paste, and this thinned by the addition of kerosene until it flows quite freely.

B.

COMPOUND FOR CREAKY SPRINGS

As an automobile repair man, I have had a great many owners complain to me about their springs creaking. A mixture of oil and graphite is often used as a preventative, but its use does not improve the appearance of the springs if they are painted a light color, as the lubricant will continue to work out for a considerable time after its application. The compound obtained by the following recipe is the best that I know of for this and similar purposes: Shave, with a knife, about three pounds of beeswax and heat the wax until it becomes a liquid; then remove it from the fire and add from 1 to 1½ pint of either turpentine or wood alcohol. Stir the ingredients and then let the compound cool off; it can then be applied between the leaves of the springs with a brush. One coating or application of this compound will do for years and it will never show on the paint. J. B. KEMP

Indianapolis, Ind.

HOW TO BLUE STEEL SCREWS

First, see that the screws are made of steel, and not iron. Next, smear them over with a little common soap, which prevents them scaling. Then heat them to a dull red, and quench in water. If a screw-head tool is available, such as watchmakers use, put the screws into that, and with a piece of stone first, and afterward with crocus emery cloth, polish the head. Finish off with rouge on a buffing wheel and see that there is no grease left on the heads. Now take a piece of thin brass, drill some holes in it, and in these drop the screws —say half a dozen, and heat them over a lamp. Watch the color as it turns from yellow to purple and then to blue. The finest blue is just before it turns to a slate color. They must be heated very gradually or you will not be able to stop the color in time. The method has proved a success where the finest blue is expected. H. D. CHAPMAN

Washington, D. C.

METHOD OF PREPARING TRACING CLOTH

I notice that Mr. Robert Lachmann, in the July issue of MACHINERY, speaks of the use of powdered soapstone and chalk for removing the greasiness of tracing cloth. In this connection I should like to mention that it is unnecessary to apply any kind of powder to the tracing cloth or paper. For some time past I have been using a piece of chamois leather to rub the paper or cloth, with perfect results. It seems to have an abrading effect, and a greasy surface that will not take the ink is instantly cured by a little rubbing with the chamois leather. A piece from 9 to 12 inches square is most convenient. It is gathered up loosely in the hand, and rubbed with a circular motion, as though polishing, applying considerable pressure. This method is handy for eliminating greasiness in any local spots on a tracing which has been touched by the fingers, as there is no powder or dust to brush away, or to get onto the inked lines.

Bath, England. FRED HORNER

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

FARWELL AUTOMATIC GEAR-HOBBING MACHINE

The Adams Co., 840 White St., Dubuque, Ia., is now manufacturing the automatic gear-hobbing machine shown in the accompanying engravings. This machine, which is known as the No. 3, is much heavier than the No. 1 size that was described in the June, 1908, number of MACHINERY, and there are also a number of interesting changes in the design.

This larger size is intended for handling work up to 24 inches in diameter, and teeth as coarse as 3 diametral pitch may be cut. The head or saddle has an unusually long bearing upon the face of the column and it has sufficient travel to permit cutting a stack of gears having a face width of 12 inches. The spindle has no unnecessary overhang and it runs in adjustable bronze bearings of ample size and length, which are rigidly attached to the saddle, as may be seen by referring to Fig. 2. As this machine was designed for cutting coarser pitches than the No. 1 size, a slide has been provided in the saddle that carries the hob, thus making it possible to adjust the hob spindle longitudinally in order to bring any tooth exactly central with the work-arbor. The way the slide is mounted in the saddle and the method of adjusting it is plainly shown in Fig. 2. This longitudinal adjustment is quite important, as it aids materially in obtaining perfect gears in coarser pitches, but it does not require attention on fine pitches as the difference in the position of two succeeding teeth is not sufficient to be noticeable in the gears. The longitudinal movement of the spindle head also makes it possible to shift the hob quickly to a new cutting position without moving the hob with relation to the spindle or arbor. Several shifts or adjustments of this kind may be made so as to bring all of the sharp cutting parts of the hob into action before grinding it.

The head has an automatic trip to stop the downward feed, and it is also equipped with a power mechanism for raising the head after the cut is finished. The head, of course, returns but once for each stack of gears, and on the small machine this operation is performed by hand. There are two extra feeds on the No. 3 hobber, making a total of ten, all of which are obtained in the gear-box shown attached to the side of the column in Fig. 1. A horizontal feed mechanism is incorporated in this new design that is employed when the machine is being used for cutting worm-wheels, as shown in Fig. 3. This is supplied without extra charge as is also the special support for the upper end of the work-arbor. This arbor support is only necessary when gears must be swung on centers, for wide-face gears, or when cutting a stack of gears of small diameter, as in Fig. 4. A more rigid support can be secured in other cases by the use of faceplates or rings which rest upon the table and support the blanks immediately below the rim.

As the engravings indicate, the spindle on this machine is driven by a universal-jointed shaft and bevel gears, instead of by a belt as on the smaller size. The 3-step cone at the rear is connected by bevel gears with the driving shaft which, in turn, transmits the power through bevel gearing to the hob spindle. This form of drive was adopted on this machine owing to the comparatively coarse pitches that it cuts, which necessitates tilting the hob to a greater angle than the belt drive referred to would allow. This angular adjustment or tilting of the hob is necessary in order to permit the cutting of various pitches with hobs of a standard diameter, the use of special hobs when required, and the cutting of both worm and spur gears on the same machine.

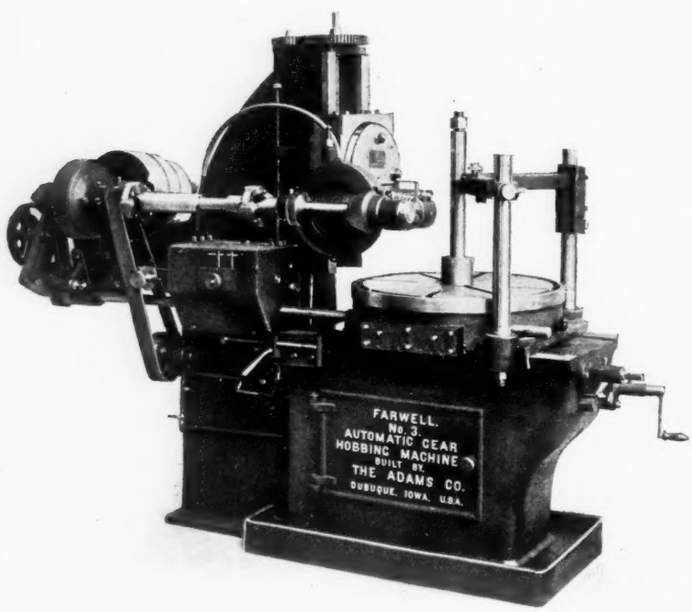


Fig. 1. Farwell Automatic Gear-hobbing Machine

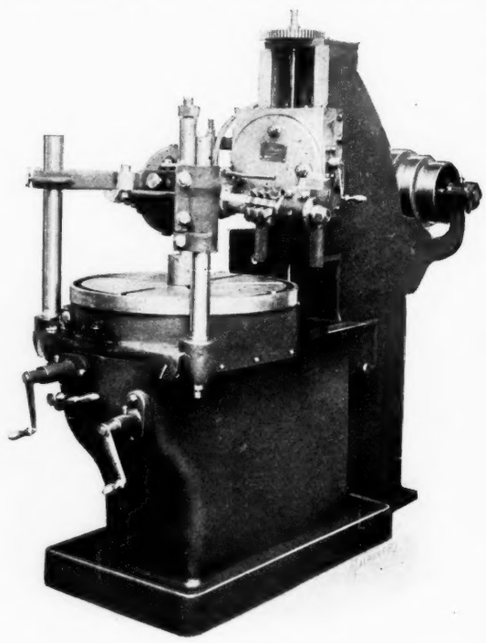


Fig. 2. Right Side of the Gear Hobber

The proper angle and also the tooth depth are obtained by means of a hardened steel gage as on the smaller machine. This gage makes the adjustment of the machine a comparatively simple operation, and it also insures accuracy. It consists of a piece tapered to the necessary angle for a certain pitch, and of the proper thickness at one end for setting the machine to the correct tooth depth.

The blanks are, of course, rotated during the hobbing operation, and the proper speed ratio between the hob and gear blank for various numbers of teeth is obtained by change gearing not unlike that on a lathe. These gears, which are mounted at the back of the machine, connect the hob-driving shaft with the one which transmits motion to the table. The speed ratio between the hob and blank is governed by the kind of hob used and the number of teeth required in the gear, it being necessary for the blank to revolve one tooth for each

revolution of the hob when a single-threaded hob is used, and two or three teeth when double- or triple-threaded hobs are employed.

All of the important bearings have bronze bushings, and spindle and arbor bearings may be adjusted by simply loosening a lock-ring and tightening an adjusting ring nut. The design of the base and column is exceptionally rigid, as these

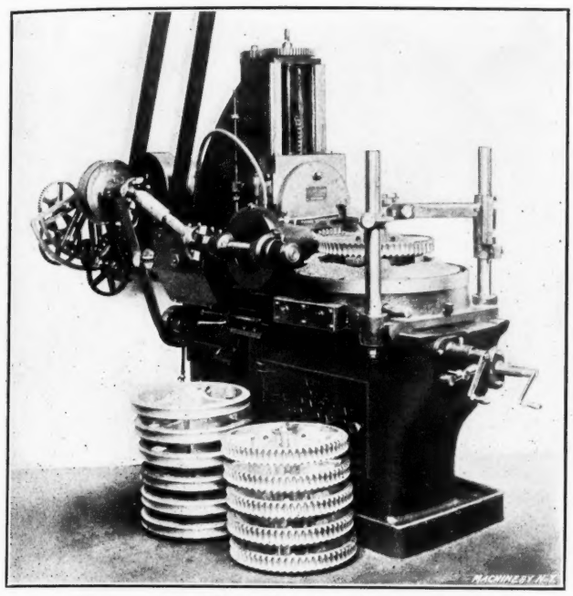


Fig. 3. Hobbing Worm-wheels on the Farwell Machine

parts, as well as the knee below the table, are formed in one casting. An oil pan is also cast integral with the base, and enclosed in the latter is a large tank for holding the lubricant, which is forced to the hob by a small gear-driven pump that has means for regulating the amount of flow. All of the gears on this machine are provided with shields for the protection of the workman, as is also the universal-jointed shaft through which the hob spindle is driven. The weight of this machine is about 2000 pounds, or approximately twice that of the No. 1 machine referred to.

CINCINNATI BICKFORD NO. 2 PLAIN RADIAL DRILL

The latest addition to the line of drilling machinery manufactured by the Cincinnati Bickford Tool Co., Cincinnati, Ohio, is shown in the accompanying engraving which illustrates a design of plain radial drill that contains many interesting and important improvements. Perhaps the most conspicuous among these is the new design of head, which is a decided departure from customary practice. Among the features worthy of note are: the length of its bearings, the simplicity of construction, the durability of its wearing parts, and the convenient location of the operating levers.

The spindle sleeve, which has an unusually long bearing in the head, exerts its pressure on the spindle through a ball-thrust bearing, and it is equipped with a safety stop for tripping the feed within its limit of movement. A depth gage is also provided that is graduated to read either in sixteenths up to six inches, or in millimeters up to one hundred and fifty, and it may be set to trip the feed at any desired depth within its range.

The reversing clutch, which is operated from the front of the head, is of the well-known toggle-joint type, and it is capable of transmitting, at its lowest speed, power far in excess of that obtainable from the belt. The quick return lever which controls the vertical movement of the spindle, engages the feed the instant it is pulled, and it is provided with convenient means for regulating the amount of expansion of its friction ring.

The feeds, which are eight in number, range from 0.006 to 0.030 inch per revolution of the spindle. Any one of these feeds may be instantly obtained by means of a lever-operated dive-key. The bearings for both the driving works and feeding mechanism, are bronze bushed, throughout, and are made of such diameter and length as to insure long life. The gearing throughout the machine is completely encased and it is arranged so as not to exceed a periphery speed of 1000 feet.

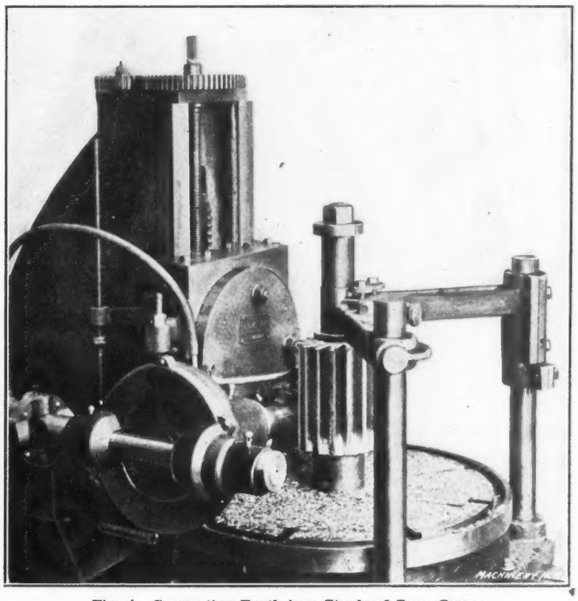
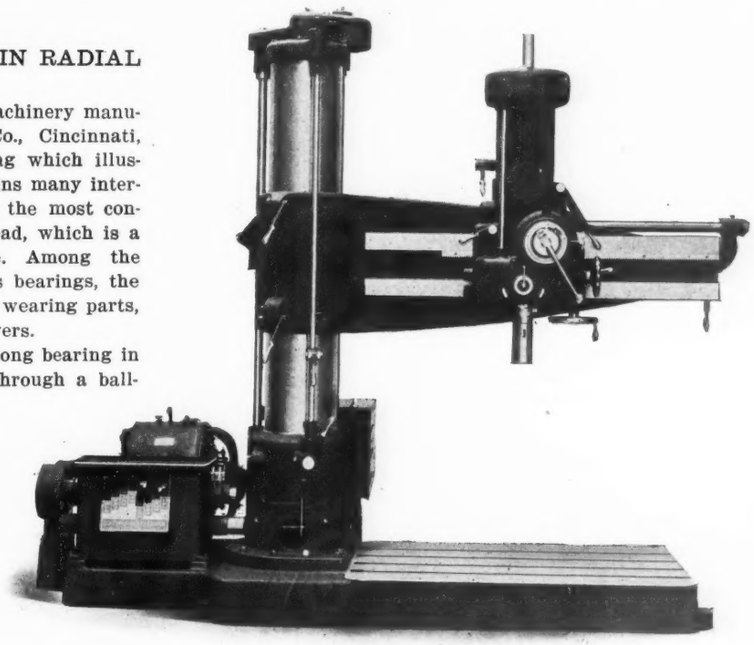


Fig. 4. Generating Teeth in a Stack of Spur Gears

The speeds, of which there are twenty-four when the machine is fitted with a speed box (as illustrated), and fifteen when fitted with a cone, are correct for a cutting speed of approximately 35 feet, on diameters ranging from 7/16 to 6 1/4 inches, the spindle speed range being from 21 to 306 revolutions per minute. The speed box, which is mounted on the base of the machine at the rear of the column, is operated by a single lever, the mere tossing of which from one notch to another furnishes any one of the eight changes. The



Improved Design of Cincinnati Bickford No. 2 Radial Drill

correct position of this lever for drills of different diameters is given beneath the notches. The back-gears are incorporated in the head and furnish three changes of speed, each of which is capable of transmitting to the spindle over 2 1/2 times the pulling power of the next faster one.

The arm lowers at twice its elevating speed and it is

strongly constructed, being made in pipe sections. The column, which extends to the top of the sleeve, is internally ribbed and is fitted with two ball bearings, one of which carries the weight and the other the side pressure of the swinging members.

The accompanying table, in which are recorded the results of drilling tests made on this machine, gives the horsepower absorbed while driving drills of various diameters through cast iron at different speeds and feeds. While in some of the tests given, as much as 16.5 horsepower was required, the makers of th s machine recommend that the size of motor be limited to 7 1/2 horsepower, as one of that capacity will usually deliver at least 11.25 horsepower. This, it will be noted by referring to the table, permits using a feed of 0.030 inch per revolution, for all sizes of drills up to and including 2 1/2 inches, at a cutting speed of 70 feet per minute or over.

These machines are built with either four-, five-, or six-foot

TABLE GIVING POWER ABSORBED BY THE BICKFORD NO. 2 PLAIN RADIAL IN DRIVING DRILLS OF VARIOUS DIAMETERS AT VARIOUS SPEEDS AND FEEDS IN CAST IRON.

Size of Drill	Speed		Feed Per Revolution			
	Revs.	Feet	0.015	0.020	0.025	0.030
			Horsepower			
1	172	45.1	4.1	4.4	4.9	5.2
1	194	50.8	4.4	4.8	5.4	5.9
1	214	56.0	5.0	5.4	5.8	6.4
1	238	62.3	5.7	6.0	6.5	7.2
1	268	70.2	6.4	6.8	7.3	8.2
1	306	80.0	7.4	7.8	8.4	9.5
1 1/4	172	56.4	5.3	5.9	6.6	7.1
1 1/4	214	70.0	6.4	7.2	7.9	8.7
1 1/4	268	87.6	7.8	8.7	9.7	11.0
1 1/4	306	100.0	8.9	9.8	10.9	12.5
1 1/2	155	60.8	5.1	6.3	7.7	8.1
1 1/2	194	76.2	6.3	7.7	9.3	9.8
1 1/2	238	93.4	7.8	9.2	11.1	11.8
1 1/2	268	105.0	8.7	10.3	12.4	13.1
1 3/4	134	61.2	5.5	6.9	7.3	8.9
1 3/4	172	78.8	7.4	8.7	9.9	11.0
1 3/4	214	98.0	9.4	10.6	12.7	14.1
1 3/4	238	110.0	10.6	11.7	14.3	16.5
2	97	50.5	6.1	7.0	7.4	9.3
2	107	55.6	6.4	7.4	7.9	9.9
2	134	70.1	6.4	7.1	8.3	10.6
2	172	90.2	7.8	9.3	11.1	13.2
2	194	102.0	8.6	10.6	12.7	14.7
2 1/4	121	71.1	8.4	9.3	10.9	11.0
2 1/4	134	78.9	7.5	8.1	9.7	9.9
2 1/4	153	90.1	8.2	9.3	11.3	11.9
2 1/4	178	105.0	9.2	10.9	13.3	14.7
2 1/2	107	70.0	7.4	10.1	10.4	11.2
2 1/2	134	87.6	7.9	10.0	10.4	11.6
2 1/2	153	100.0	9.8	10.9	11.6	13.6
2 3/4	97	69.9	8.5	10.3	11.8	13.5
2 3/4	107	77.0	9.6	11.4	13.2	14.7
2 3/4	121	87.1	11.1	13.1	15.2	16.3
3	89	70.0	8.9	10.5	12.2	13.9
3	107	84.0	11.1	12.2	13.7	14.7
3	121	95.0	10.9	12.3	13.8	15.3

arms. Some of the principal dimensions for these three sizes are as follows, the figures being given in the order mentioned: The vertical range of the arm is 3 feet 6 inches for the three sizes, and the horizontal traverse for the head is 3 feet, 5/8 inch; 4 feet, 5/8 inch; 5 feet, 5/8 inch. The maximum and minimum distances from the spindle to the base, are 6 feet, and 12 inches, respectively for the three sizes. The bases have a working surface of approximately 3 1/2 feet by 4 feet 3 inches, 3 1/2 feet by 5 feet 3 inches, 3 1/2 feet by 6 feet 3 inches. The spindles for the three machines are bored to receive a No. 5 Morse taper, and their drilling capacities, in the plane of the base, are to the centers of 8-, 10-, and 12-foot circles.

HILL FRICTION CLUTCH—SMITH TYPE

The use of friction clutches in connection with the transmission of power, has increased to such an extent that they are now employed in almost every industry. The convenience and economy resulting from the possibility of cutting off one or more machines, shafts, or entire sections of the shop without disturbing other machinery in operation, are well-known factors in maintaining uninterrupted service and reducing the cost of production.

The latest design of friction clutch manufactured by the Hill Clutch Co., Cleveland, O., is shown in the accompanying engravings. In this new clutch, which is known as the Smith type, the same principle of action is retained that has been

Fig. 1. Friction Clutch built by the Hill Clutch Co.—Four-arm Type

employed in the well-known standard type of clutch manufactured by this company. A number of changes and improvements in design and construction have been made, however, in this latest design to adapt it for heavier and more continuous service.

These clutches are built with three, four and six arms, according to their capacity. In Fig. 1 the four-arm type is shown, while Fig. 2 illustrates a larger size that has six arms. The friction surfaces are wood against iron, which is a combination offering great frictional resistance, and the shoe area is exceptionally large. The coefficient of friction is said

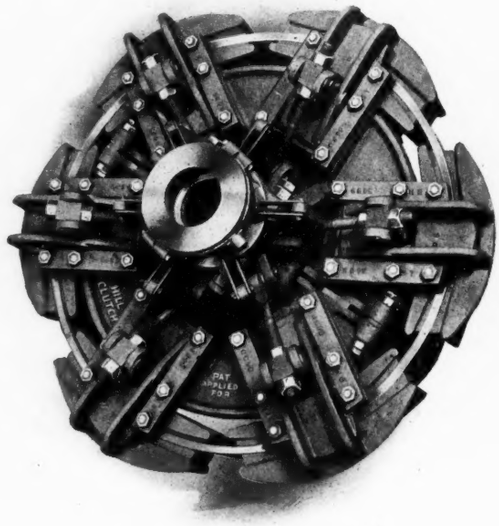


Fig. 2. Hill Friction Clutch with Six Arms

to be the same at all points, owing to the heavy cast-iron jaws, rigid guides, and the balanced toggle action through which the pressure is applied. The action of the clutch mechanism is positive, no springs being used in the construction. The sectional view, Fig. 3, shows the simple, powerful and continuous toggle connection from the cone to the jaws,

which positively releases, as well as engages, the friction surfaces. All of the toggle mechanism is of steel castings or forgings with the single exception of the connecting levers, which are of cast iron.

Another noteworthy feature in the design of this clutch is that any working part, including the inside jaws, may be removed parallel to the shaft from the mechanism side. This can be done without disturbing the main spider casting or pulley, as bolted gib guides secure the inner and outer jaws to the spider as shown in the illustrations. The entire clutch

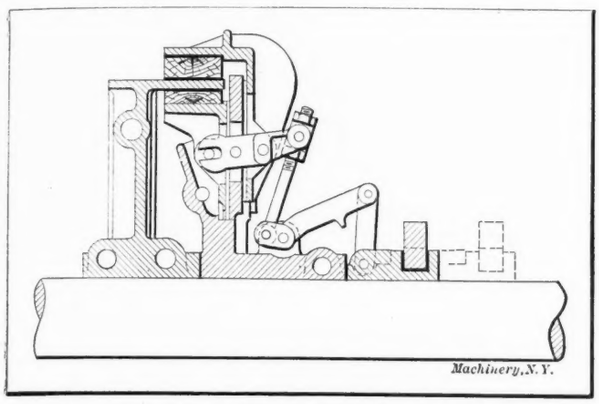


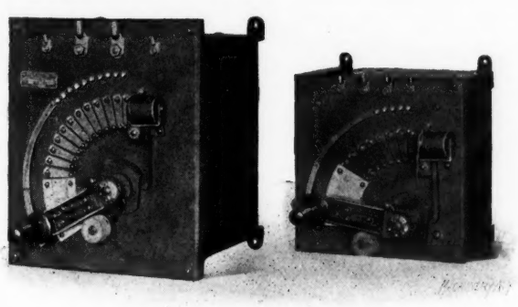
Fig. 3. Sectional View showing Construction of the Hill Clutch

mechanism is open and accessible for adjustment and the removal of shoes when necessary. The clutch pulleys are mounted upon split removable sleeves, babbitted or bronze lined as specified, which can readily be replaced without removing the pulley or clutch.

Another important advantage claimed for this clutch is its self-centering feature. As all jaws fulcrum at a point equidistant from the center of the shaft, they form a perfect centering or shaft aligning device without the necessity of troublesome shaft bushings. The clutches are built in either the solid or split types. In the split construction the bolting lugs are so distributed as to offer the greatest resistance to the forces tending to part the clutch. These clutches are built in nineteen sizes, ranging in capacity from 9 to 1,300 horsepower at 100 revolutions per minute.

GENERAL ELECTRIC SPEED CONTROLLERS

A line of speed controlling rheostats has been brought out by the General Electric Co., of Schenectady, N. Y., so designed that they combine in a single box both armature and field regulating rheostats. All speed changes are effected by movements of a single rheostat arm, which is automatically held in any position by a mechanical device. The line in-



General Electric Speed-controlling Rheostats

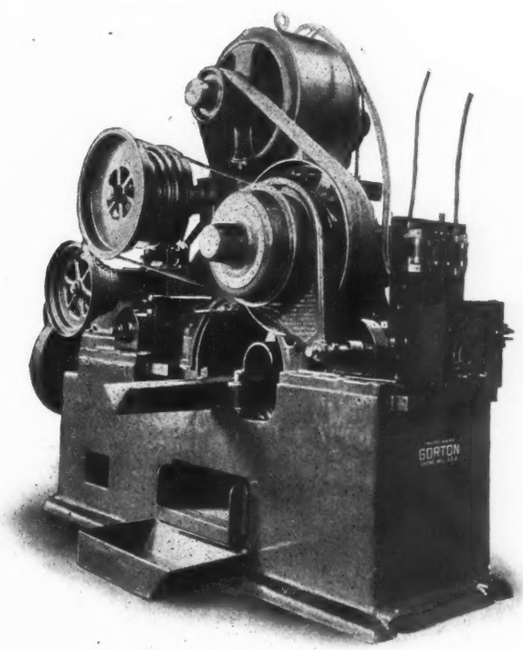
cludes rheostats designed for machine tool service, where full load current is taken at the lower speeds in order that the motors may maintain a constant torque, and also for fan service where the load increases with the speed. They permit of a 50 per cent reduction in speed by armature control and a 25 per cent increase by field control.

For protection from failure of voltage and the consequent danger of power being again thrown on the line without resistance in series with the motor armature, they are provided with a no-voltage release attachment. Upon failure of the voltage, the retaining magnet is demagnitized, thus releasing the arm which is instantly returned to the off position, by a spring, making it absolutely impossible to close the armature circuit without cutting in all the armature controlling resistance. The no-voltage release coil is connected directly across the line in series with a resistance and is thus independent of the current of the motor field and will protect any motor with which this rheostat may be used.

The contact segments are of liberal size and so designed that they may be very easily and quickly renewed. The resistance units are of an improved design and are so constructed as to be non-fragile, and thoroughly ventilated. These rheostats are designated as the CR-164 type, or CR-165, when equipped with an overload release coil.

GORTON CUTTING-OFF MACHINE

In the department of New Machinery and Tools for October, 1909, we published a description of a heavy-duty cutting-off machine built by the George Gorton Machine Co., of Racine, Wis. This machine has recently been equipped with the new type of electric drive shown in the half-tone illustration. As those familiar with the construction of the machine know, the main drive is through a large gear (not



Rear View of Gorton Cutting-off Machine showing the New Electric Drive

shown in the illustration) having an enlarged hub to which the cutter blade with its inserted teeth is attached. Meshing with this main gear is a driving pinion, to the end of which is secured the main driving clutch. On the motor-driven machines, the motor is allowed to run constantly and the machine is started and stopped with this clutch, which is operated by a lever located in a position convenient to the operator. The motors on the electrically-driven machines may be connected to the clutch pulley with an endless leather belt, as shown in the illustration, or, if desired, connection may be made with a silent chain drive. On the standard motor-driven machine, a 20-horsepower motor is installed which operates at 800 revolutions per minute. When the material to be operated upon varies from soft to quite hard, the manufacturers recommend a 2 to 1 variable speed motor.

This illustration also shows the belt feed drive which has been found preferable to an all-geared drive. Feeds ranging from 6 inches in four minutes to 6 inches in one minute, are available. The lower cone-pulley shown is connected with a gear-box containing the forward and quick-return feed clutches, which are operated either by hand or automatically

at the extremes of the stroke, adjustment being provided for various diameters of stock.

This machine, which is designated as the 2-B, is adapted to hard service, such as is found in rolling mills, etc., and it has a capacity for round steel bars up to and including 6 inches in diameter; stock as large as 8 inches, however, may be severed when necessary. This latest design has a record of 40 seconds for severing a 6-inch round steel bar, and stock of this size can be severed day in and day out in 1½ minute per cut.

QUEEN CITY SAFETY STOP-CLUTCH

A new automatic safety stop-clutch for punching and shearing machinery has recently been designed and patented by Mr. C. F. Heinss of the Queen City Punch & Shear Co., Cincinnati, O. This clutch, which is engaged or disengaged automatically,

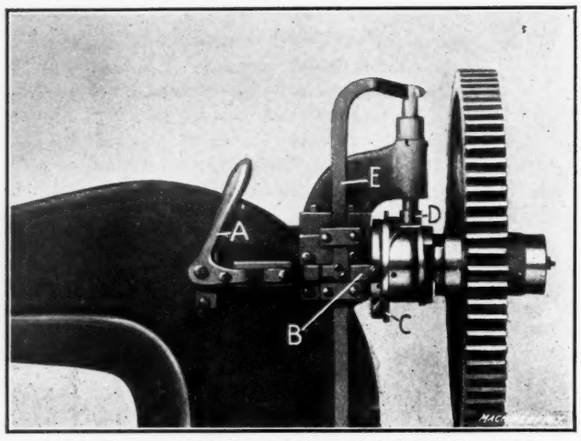


Fig. 1. The Queen City Punch & Shear Co.'s Safety Stop-clutch

is positive in its action and is so designed as to provide safety for the operator while punches and dies are being adjusted, without the necessity of throwing off the driving belt, as is commonly done.

Fig. 1 shows the clutch in the operating position, while Fig. 2 shows it in the safety position, the clutch being entirely disengaged by simply throwing hand lever *A* to the position shown. Attached to the clutch there is a ring or collar on each side of which are cams. The cam on the gear side disengages the clutch, while the one on the opposite side operates spring-plunger *B*. When the operator presses the lever or foot-treadle, thus raising rod *E* and with it plunger *D*, the spring-actuated plunger *B* comes against the collar *C*, thus forcing

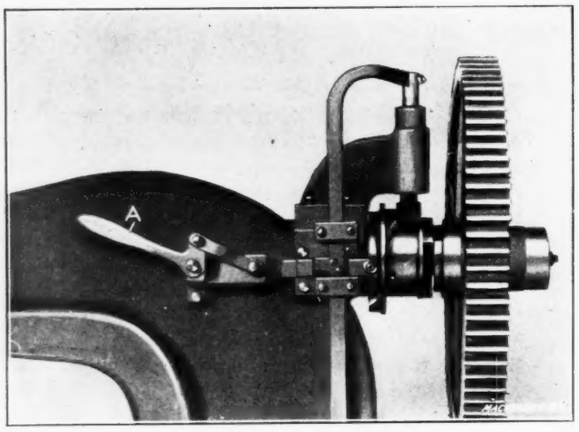


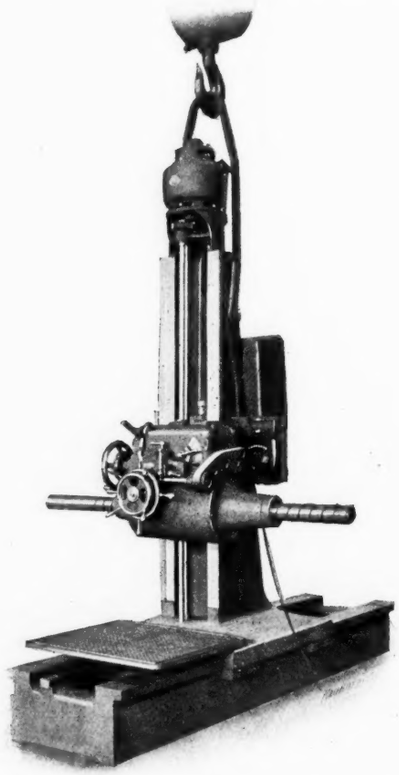
Fig. 2. Stop-clutch in the Safety Position

the clutch over and engaging it with the driving gear. After the cam has made part of a revolution, a cam surface engages plunger *B*, forcing it back and allowing rod *E* and plunger *D* to descend. As the clutch continues to turn, the cam surface on the gear side comes against plunger *D* and forces the clutch out of engagement. It will thus be seen that the release of this clutch is positive, and also that plunger *B* is locked in position after the cam forces it back, as a projecting piece attached to rod *E* engages a lug on *B* when rod *E* has descended to the position shown in the illustrations. Plunger *B* remains in this locked position until *E* is again released by the treadle, when the plunger is pushed forward and the cycle of operations is repeated.

The clutch is, of course, a very important feature in punching and shearing machinery, and the general efficiency and durability of this new design is evidenced by the fact that it is being installed on all of the machinery manufactured by the Queen City Punch & Shear Co. which requires such a device.

ROCHESTER HORIZONTAL BORING MACHINE

In the department of New Machinery and Tools for July, 1910, a horizontal boring, drilling, tapping and milling machine built by the Rochester Boring Machine Co., Rochester, N. Y., was described. The accompanying illustration shows a new application of this machine, the column and column-slide being detached from the main floor-plate so that this part may be used either as a stationary or as a portable machine, as desired. A heavy strap is attached to the column so that the



Rochester Horizontal Boring Machine Converted into a Portable Tool

machine may be conveniently moved by a crane. The side of the column-slide or base is arranged with dowel-pins so that it may be easily located with reference to the floor-plate. This slide is also equipped with screws which serve as jacks when it is being disengaged from the floor-plate.

AUTOMOBILE MANUFACTURERS BALL BEARING DRILLING MACHINES

The Henry & Wright Mfg. Co. of Hartford, Conn., has recently designed a new line of drilling machines, illustrated herewith, in which are incorporated all the good features of the smaller machines built by this company and some additional improvements which add very much to the practical value of the machines for doing the work for which they are intended. They are much heavier and more rigid than former designs, and are fully equipped with ball bearings, which are made interchangeable and may be renewed at small expense,

when required, thereby prolonging the life of the machines indefinitely.

The power of these machines is sufficient to drive high-speed drills efficiently in sizes ranging from 1 1/8 inch down to the smallest sizes. The spindle drive is located at the lower end of the spindle pulley instead of at the upper, as formerly, thus giving a more rigid drive to the spindles. The drive is encased in a cup which excludes dust and retains the oil which otherwise would be thrown about the room. The spindle pulley is supported above and below the belt instead of below only, as is the usual custom, thus relieving the spindle from all belt pull and compelling it to rotate in a correct manner, insuring accuracy at the drill point. The limit of accuracy of the spindles is 0.002 inch in an eight-inch circle. The spindle sleeve has an inserted steel rack, and adjustable stops are furnished (as ordered) to fit either the spindle at the top of the pulley or the rack. For accurate drilling or counterboring to a specified depth, the stop for the rack sleeve is recommended.

The idler pulleys are balanced, and the pulley bracket is provided with a guide which encloses the belt and prevents it from slipping off when changing the speeds. The machines are entirely belt driven and they are made with from one to six spindles each, and in three overhangs—eight-inch, twelve-inch, and fifteen-inch. The spindles are driven with an endless belt 1 3/4-inch wide, and the rear shaft is driven by a 2 1/2-inch belt. The wider belt driving the rear shaft is designed to furnish sufficient power to enable two operators to work on the same machine, when desired, and individual spindles may be started or stopped without stopping the entire machine.

The tables are made especially heavy and with extra wide

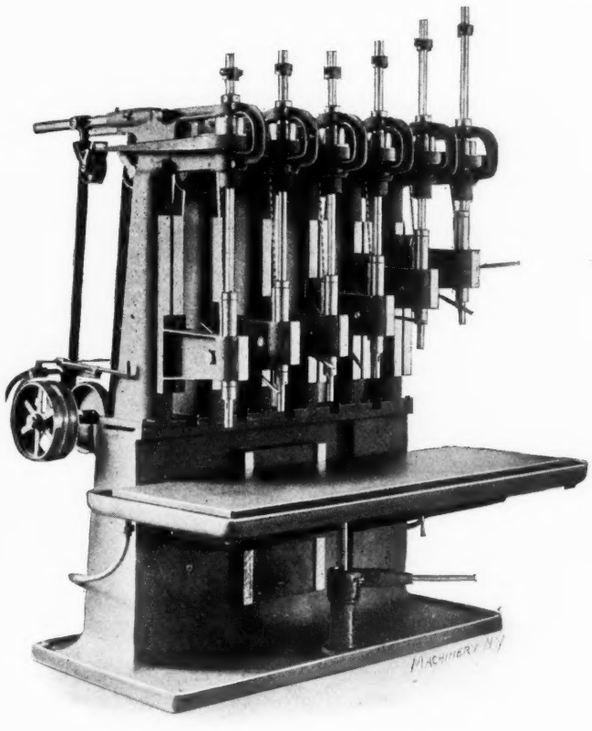


Fig. 1. Henry & Wright Six-spindle Drilling Machine

and long ways, and they are all equipped with a handwheel and raising screw. While every precaution has been taken to furnish a table as stiff and unyielding as is necessary to drill the heavy work it is designed to do on these machines, additional support is furnished by two supporting jacks at the outer corners of the table. The oil grooves around the tables are extra wide and deep, and both ends may be fitted with tubing to connect with an oil tank inside the base. A rim is cast around the foot of the base to prevent oil from flowing off the machine to the floor. The raising screw of the six-spindle machine illustrated is fitted with a ratchet instead of the usual handwheel, to furnish greater leverage to the operator in raising and lowering the heavy table.

Some idea of the proportions of these machines may be gathered from the following dimensions of the number six size: Height of machine overall, 8 feet 6 inches; height of base from floor, 36 inches; distance between the spindle centers, 10 1/4 inches; greatest distance between bottom of spindle, when raised to its highest point, and top of table when lowered to its lowest point, 30 inches; diameter of spindles, 1 1/8 inch; dimensions of table surface, 75 inches by 24 inches; floor space, 6 feet 9 inches by 5 feet 2 inches; and net weight of complete machine, 5500 pounds.

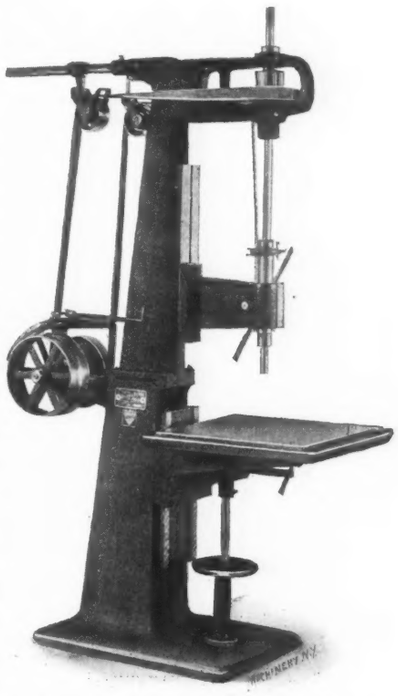


Fig. 2. Single-spindle Drilling Machine built by the Henry & Wright Mfg. Co.

These machines were especially designed to handle the variety of work necessary in the manufacture of automobiles and kindred modern manufactures. Many of the principal new features were brought out during a course of over three years of experiments which the makers conducted in connection with one of the largest users of their product. During this time the various experimental machines underwent the closest criticism by competent men, and the efficient machine, two sizes of which are shown, is the final result.

QUEEN CITY SAFETY FORMING PRESS OR MULTIPLE PUNCH

A large multiple press which is the product of the Queen City Punch & Shear Co., Cincinnati, O., is shown in Figs. 1 and 2. This machine has been built for punching angle-bars, punching two at a time on one side in one stroke, thereby completing the bar on both sides in one operation. It is similar in principle to the press previously described in the department of New Machinery and Tools for September, 1909, though much larger, heavier, and of a different design.

One of the distinctive features of these presses is the oscillating table which eliminates all danger of injury to the operators. This oscillating movement is obtained by a large face cam which, on the particular machine illustrated, is mounted on the main driving shaft. This cam transmits the required movement by suitable levers to the shaft on which the table is mounted. With this arrangement, the table and its dies are moved from under the plunger when the work is finished, so that the latter can be removed and a new blank inserted without danger of accident. Fig. 1 shows the table in the working position, while Fig. 2 shows it moved forward, where it is allowed to remain stationary long enough to permit the removal of the finished work and the insertion of a new blank.

Presses of this class are built with either a single or double set of dies. When a double set of dies is employed, two operators are required, one being stationed at the rear of the machine and the other at the front to feed and remove the work. The action of the double-action type of machine is as follows: After the work has been formed in one set of dies, the latter remains stationary until the plunger is partly raised.

Then the dies in which the work has been formed or pressed, as the case may be, move forward to the operator, who removes the finished work and inserts another blank. In the meantime the opposite set of dies is receiving the plunger so that the machine is in operation continuously. With the single type press, such as the one illustrated, the general operation is practically the same as with the double dies, except that only one operator is required. The double-action type can be employed on a multiple punch when the work is light and can

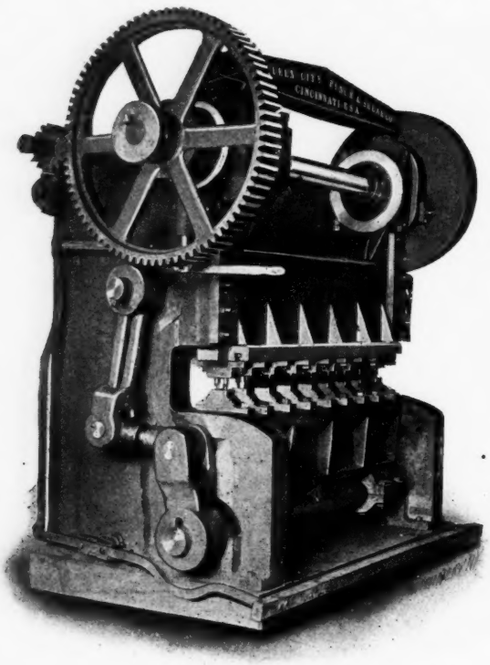


Fig. 1. Large Forming Press built by the Queen City Punch & Shear Co.

be easily handled, but when it is comparatively heavy, the single action is recommended.

It will be seen from the foregoing that the oscillating table makes it unnecessary for the workman to place his hands or fingers near the dies while feeding or removing the work, as the dies come forward to a safe position. These machines are

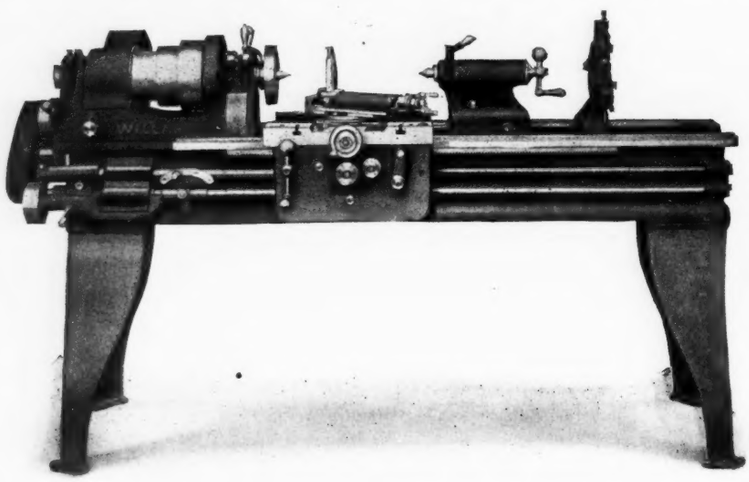


Fig. 1. Engine Lathe built by the Willard Machine & Tool Co.

provided with an automatic safety stop-clutch which stops the plunger when the latter is in its upward position. The particular press illustrated, measures 62 inches between the housings, and it weighs approximately 20,000 pounds. It is equipped with machine-cut gears, which insure a smooth and noiseless operation. These machines are built in various sizes and styles to meet the necessary requirements or nature of the work to be handled.

WILLARD HIGH-POWER 13-INCH ENGINE LATHE

The Willard Machine & Tool Co., Cincinnati, O., is now manufacturing the high-power 13-inch lathe shown in Fig. 1. This machine is designed and built to withstand the strains imposed by the use of the best high-speed steel tools. Standard jigs and gages are used in its manufacture, so that all parts are practically interchangeable. The lead-screws and feed-rods

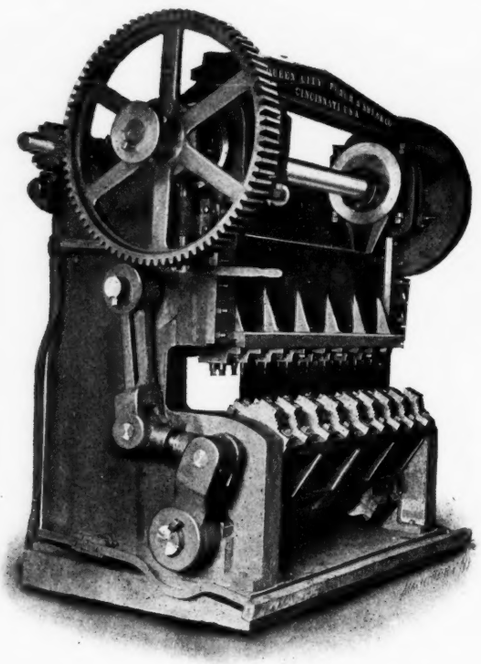


Fig. 2. Queen City Press with Oscillating Die-bed in Position for Removing Work

are made from special high-grade carbon steel. All sliding surfaces are carefully scraped to a bearing, and the spindles, as well as all other cylindrical parts, are ground to insure accuracy.

It will be noted by referring to Fig. 2, which shows an enlarged view of the headstock end, that all gears are covered for the protection of the workman. The large dial *B* of the cross-feed is graduated to read to thousandths of an inch, and graduations are also provided for the feed-screw of the compound rest. The feed-belt on this machine is 1½-inch wide and it runs on large pulleys of equal diameter, giving a very powerful feed. This belt can be kept at the proper tension at all times by means of a tightener. Four changes of feed are provided, any one of which may be instantly obtained by simply moving the lever *C* to one of the four positions on the quadrant. A safety mechanism in the apron prevents the engagement of the half-nuts, when either feed is connected, thus preventing breakage. This machine is equipped with double back-gears, which are operated by the handle at *A*. This handle has a latch, which by engagement with a suitable hole, locates and positively locks the back-gears in position. The countershaft has two forward speeds of 350 and 450 revolutions per minute, and these speeds, together with the changes obtained by the back-gears, give eighteen speed changes ranging from 30 to 655 revolutions per minute. The driving cone has three steps, and the width of the driving belt is 2½ inches. The headstock is heavily built and it has a bearing of 21½ inches on the bed. The spindle, which is of 60-point carbon, crucible, spindle steel, has a front journal 2⅝ inches in di-

ameter by 4 inches long. The bearings are of high-grade phosphor-bronze and are carefully scraped to fit the spindle. The reverse gears are of steel and the idlers are bushed with phosphor-bronze. The tailstock, which is well proportioned, has a crucible steel spindle 1¾ inch in diameter. The carriage has a bearing of 18 inches on the V's and the bridge is 7½

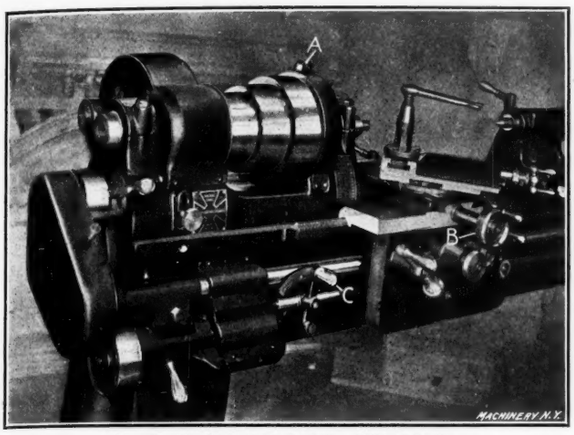


Fig. 2. Headstock End of the Willard Lathe

inches wide. The apron and the bearings in it are cast in one piece, thus making it stiff and strong. All gears located in the apron are of steel and the studs are hardened and ground.

This machine swings over the ways 13½ inches and over the carriage 7¼ inches. The maximum distance between the centers with a 6-foot bed is 37 inches. The spindle has a 1 5/16-inch hole through it, and it is bored to receive a bushing bored for a No. 3 Morse taper. The ratio of the first back-gear is 3 to 1 and of the second back-gear, 8 to 1. The weight of the machine with a 6-foot bed is 1300 pounds.

This type of lathe, while being used for turning lathe spindles, removes 203 pounds of 60-point carbon spindle-steel chips in ten hours, reducing the stock from 2½ to 2 inches in one cut, while running at 68 feet surface travel per minute and feeding 0.013 inch per revolution. It also reduces 2½-inch machinery steel to 2 inches, while running at a surface speed of 136 feet per minute and feeding 0.013 inch per revolution. These figures speak for themselves.

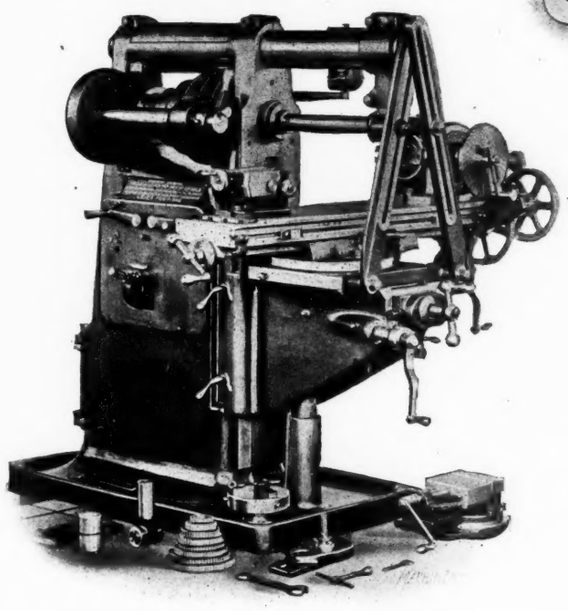


Fig. 1. Modern Cone-driven Milling Machine built by the Cincinnati Milling Machine Co.

CINCINNATI CONE-DRIVEN MILLER

In every shop there is a class of milling work that is comparatively light, which can be done on a modern cone-driven miller as fast and as accurately as on the more highly-developed single-pulley type of machine. It follows, therefore, that the cone-driven machine is the most economical one to use on such work. There is, of course, a recognized field for the heavy and powerful single-pulley type of milling machine, but this does not in any way restrict the field of usefulness of the cone-driven machine. That these facts are appreciated by the Cincinnati Milling Machine Co., Cincinnati, O., is evidenced by their having re-designed their entire line of cone-driven millers.

The illustrations presented herewith show the more important improvements that have been made. The column is very similar to the column used on their line of high-power machines, it being a symmetrical box section that is large enough to contain the entire feed driving mechanism. The feed changes are all obtained from a single group of mechanism which is mounted in the column at a point high above the floor, thus bringing all the levers within easy reach, and the index-plate in plain sight of the workman. The interior of this mechanism is shown to the left in Fig. 2. As the illustration shows, the various gears, when assembled in their case, form a single compact unit, which, when placed in the column, becomes an integral part of the machine. This mechanism provides sixteen changes of feeds ranging from 0.007 to 0.300 inch per revolution of the spindle or cutter, and all of these changes are obtained by means of the twelve gears located between the two housings of the gear case. The drive is direct from the face-gear which meshes with gear *A*, and

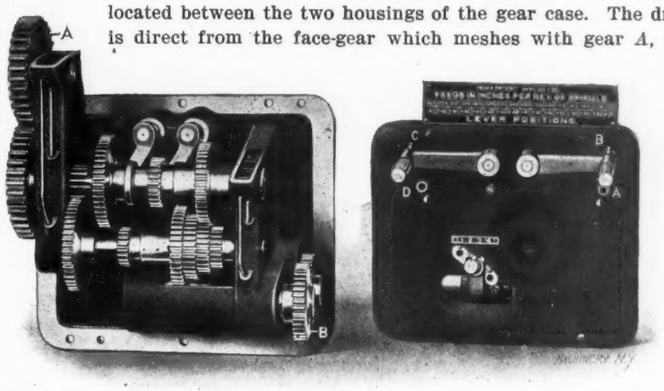


Fig. 2. The Feed Changing Mechanism and Controlling Levers

power is transmitted through the change gears to the gear *B*, which drives the universal-joint shaft. An exterior view of the feed-box, showing the lever arrangement and the feed index, is shown to the right in Fig 2. All the sixteen feed changes are obtained by manipulating the three levers shown, and their positions are clearly indicated by the feed index plate which is mounted just above them. This plate is of the same simple form that is used by this company on their line of high-power machines. It is so arranged that there is no chance for confusion, because the exact lever positions are plainly given below the figures representing the feed rates, so that it is simply necessary for the operator to move the levers to these positions. For example, if a feed of 0.088 inch per revolution of the spindle were required, the mark "3-BC" on the plate, just below 0.088, would show that the tumbler should be moved to position "3," the right-hand lever to position "B," and the left-hand lever to position "C," as illustrated.

The most striking feature in the design of this feeding mechanism is the tumbler construction. This tumbler is made in the form of a cylinder of large diameter, which supports the tumbler shaft and gear and is itself supported in the frame of the feed-box. This construction obviates all bending of the tumbler-shaft as well as all vibration in the tumbler itself. The tumbler-operating lever projects through a hole in the feed-box in the usual way, as shown, but this opening is completely closed at all times by the tumbler, thus thoroughly protecting the inside mechanism from dust.

ROWBOTTOM BALL-BEARING DISK GRINDER

The Rowbottom Machine Co., of Waterville, Conn., has designed and is placing on the market a new line of disk grinding machines, the 18-inch size of which is shown in Fig. 1. This company has departed from the regular method of construction in this class of machinery by mounting the spindle in ball bearings. The sectional view, Fig. 2, shows the construction of these spindle bearings. The ball bearings, which are of the well-known Hess-Bright type, are connected with grease cups, which insure a supply of lubricant without attention, for months at a time. On the right-hand end of the machine a sliding table is provided having two T-slots for fastening angle-plates or fixtures. This table is controlled by a hand lever, and an adjustable stop-screw limits the inward motion to insure a uniform thickness of the work being

Fig. 1. Rowbottom Ball-bearing Disk Grinder

ground. The table also has an angular adjustment with relation to the face of the disk, and the whole has a balanced swinging motion across the disk face. The table on the opposite side of the grinder is of the plain type, and it has a lip or projection on the front edge which is square with the face of the disk. This is very convenient for grinding the ends of pieces square with the edges. This table also has the angular adjustment and the balanced swinging motion. Provision is made for fastening either table in a fixed position when desired, and both tables are adjustable in a vertical direction to allow the greatest surface to be presented to the

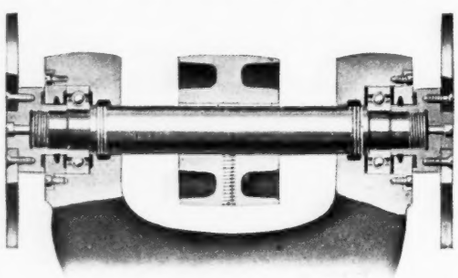


Fig. 2. Sectional View of Disk Grinder Spindle Bearings

most effective cutting part of the disk. A water pot is attached to the machine, as shown, which is convenient for cooling pieces on which heavy grinding has been done. Three sizes of these machines are made, the disks of which are 12, 18 and 26 inches in diameter, respectively. After thorough tests, the builders are convinced that they have a machine that is not only durable, but also economical in the use of power, both of which are valuable and important features.

LANDIS STATIONARY DIE-HEAD FOR PIPE THREADING

A stationary die-head for pipe threading, which is now being manufactured by the Landis Machine Co., Waynesboro, Pa., is shown in Fig. 1. This head, which is manually operated, is equipped with the Landis type of die, and is made especially for use on pipe threading machines wherein the

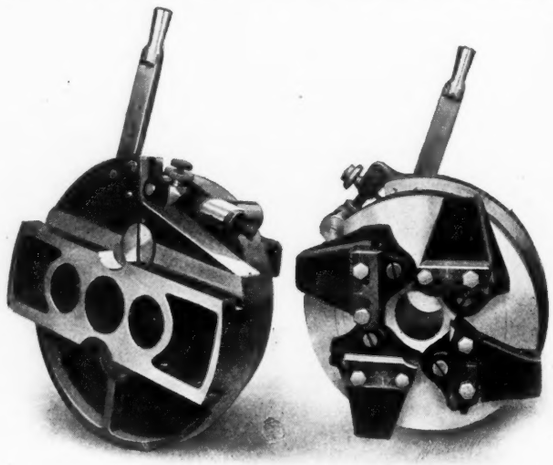


Fig. 1. Landis Manually-operated Die-head for Pipe Threading

pipe revolves and the head remains stationary, the dies being opened and closed by hand. It is made entirely of steel, as are also the die-holders, and it can be mounted on the carriage of any of the standard pipe machines. The chasers used in this die-head are of the company's regular type, in which the teeth are milled; they can be advantageously made from high-speed steel as they never require to be annealed, re-hobbed or re-tempered. (An illustration showing this type of chaser appeared in the department of New Machinery and Tools, for February, 1908.) The sharpening of the die is a simple operation as it consists simply in grinding the ends of the chasers, and again setting them to the correct cutting position in the holders by means of the small gage furnished.

In Fig. 2 is shown one of the holders that is used for pipe threading when it is not necessary to cut very close to a

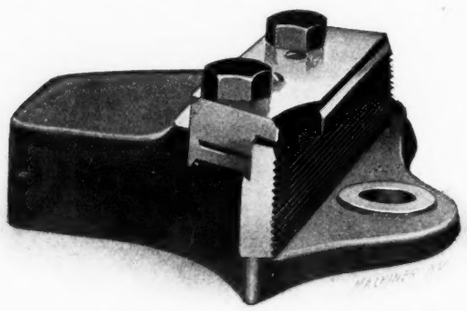


Fig. 2. Detail View showing One of the Chaser Holders

shoulder. The clamp by which the chaser is held in place, is what is known as a "mill" clamp. This clamp, besides holding the chaser rigidly, protects it in case the pipe splits, which is a frequent occurrence. As the illustration shows, the clamp extends down over the throat of the chaser, and it is rounded out near the cutting point so as to act as a guide for rough ends and to protect the die from breakage when a "twister" occurs in the pipe, as the greater part of the strain is thrown on the clamp. When it is desired to thread close to a shoulder, as when threading short nipples, etc., a clamp is used which comes flush with the front edge of the chaser only, thus permitting the die to run close up to the shoulder.

Durability of the chasers, high cutting speeds, and the adaptability of the die to the different qualities of material, are among the important advantages claimed for this die. It is said that it permits of cutting speeds from 25 to 100 per cent higher than those employed with the hobbed type of die, and

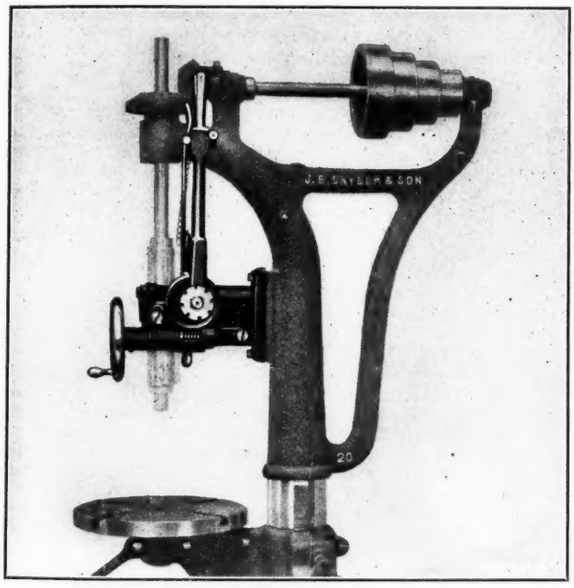
the rake on the chasers can be ground to suit the quality of the material in the pipe to be threaded. This is important, as much of the pipe on the market to-day is stringy and tough so that a change in the angle of rake is essential.

The heads are graduated for setting the dies to different diameters. They are opened and closed by a hand-movement of the lever shown, and when in the closed position the die is rigidly locked. All dies are made to interchange perfectly and if one chaser of the set should be worn out before the others, this single chaser can be replaced without replacing the entire set. Dies of any one pitch will interchange on any of the die-heads so long as the pitch is within the range of the head. For example, dies for threading 1-inch pipe on the 1-inch head, will also thread 1-inch pipe on the 2-inch head or *vice versa*, thus avoiding the necessity of carrying a large assortment of dies to cover the range of work when using a number of heads.

These heads are made in four standard sizes with capacities as follows: from ¼ to 1 inch, inclusive; from ¼ inch to 1½ inch, inclusive; from ½ to 2 inches, inclusive, and from 1 inch to 4 inches, inclusive. One set of dies will cut all diameters of pipe coming within the same pitch. For example, there is but one pitch covering the sizes ranging from 1 to 2 inches, inclusive, therefore one set of dies covers this range, and the same is true of the other sizes.

SNYDER 20-INCH UPRIGHT DRILL

In the New Machinery and Tools department for August, we described a 20-inch upright drill recently brought out by J. E. Snyder & Son, Worcester, Mass. We failed to mention, however, the new design of head which is an important feature, as it adds considerably to the convenience of operation.



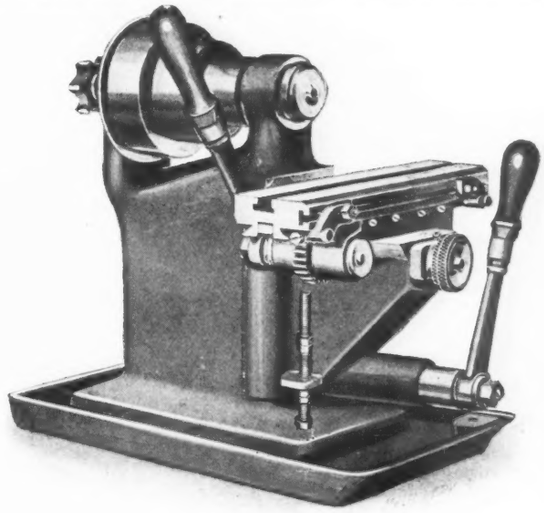
New Design of Head on 20-inch Upright Drill built by J. E. Snyder & Son

By referring to the accompanying illustration, it will be seen that the wheel-shaft bracket which contains the worm-shaft and worm for the hand feed, is pivoted at the outer end so that the worm may be engaged or disengaged by simply raising or lowering the wheel. When the wheel is pushed up, it is held by a latch which drops into place automatically. The economy resulting from this device is apparent.

CARTER & HAKES BENCH MILLING MACHINE

A bench milling machine that is adapted for a large variety of light work, such as is found in the manufacture of guns, sewing machines, typewriters, electrical supplies, etc., is shown herewith. This machine is a recent design of The Carter & Hakes Machine Co., Winsted, Conn. It is built in two styles, the first being a hand milling machine with or without a vertical attachment, and the second a machine with both hand and power feeds for the table, the power feed being engaged or disengaged by simply tightening or loosening a screw.

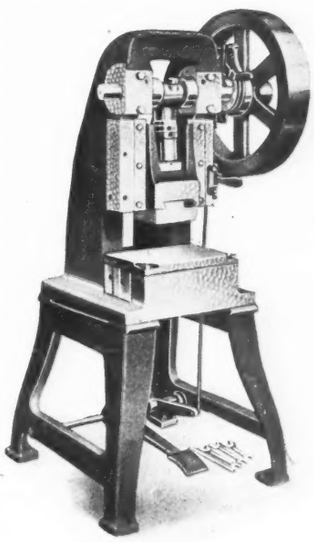
The column is designed to give strength and rigidity where it is most needed, and it is for this reason that the spindle cone has been reversed, which allows giving the front bearing a rigid support. The knee is of the box design and it is counterbalanced by a weight within the column. The carriage projects well out on each side of the knee, thus providing a good support for the table. The latter has a longi-



Carter & Hakes No. 3 Hand Milling Machine

tudinal feed of 4 inches and a cross movement in line with the spindle of 2¾ inches. The feed-screw for the transverse adjustment is furnished with an index graduated in thousandths. The spindle, which is of special forged steel, has a Brown & Sharpe No. 9 taper hole. The bearings run in bronze bushings of the split taper type, thus providing means for taking up wear. Both the vertical and horizontal feeds are through rack and pinion movements, and eccentric bushings are used as bearings for the operating levers, so that backlash can be eliminated at any time by simply adjusting these bushings. The vise furnished with this machine is the company's regular No. 2 quick-operating lever vise, which has a maximum opening of 3¼ inches.

The machine can be set on a bench or platform, or, if desired, a column for floor use can be furnished. The weight with vise and countershaft is 150 pounds. The greatest distance from the top of the table to the center of the spindle is 4 inches, and the table is about 3 inches wide by 12 inches long. The knee has a vertical range of 4 inches, and the total height of the machine is 16¾ inches. The regular equipment for both hand- and power-fed machines includes an overhanging arm for the support of the cutter arbor; a taper spindle sleeve bored to receive a Rivett collet; one collet with a draw-in attachment; a lever vise, countershaft, and the necessary wrenches.



Baird Blanking and Stamping Press

BAIRD OPEN-BACK PRESS

A new design of open-back press which has recently been brought out by the Baird Machine Co., Oakville, Conn., is illustrated herewith. This press has been heavily designed

as it is intended for performing heavy blanking and stamping operations. The machine illustrated is of the plain type, but several unique attachments have been designed which can be applied when necessary. Among the good points in the design may be mentioned the long slide, the strong support given to the bearings, the heavy balance wheel, and the convenient positions of the hand lever and foot-treadle for operating the clutch mechanism. As the illustration shows, the machine has finished seats which make the application of attachments comparatively easy. If desired, either the back or side roll feed transfer attachment, or dial attachment, can easily be applied to one of these plain presses without the necessity of shipping it to the factory, as the attachments are carried in stock. This machine is built in four different sizes.

NEW MACHINERY AND TOOLS NOTES

Crankpin Turner: Schwinebraten Portable Crankpin Turner Co., Birmingham, Ala. Portable machine for turning worn locomotive or other crankpins. It is attached to the end of the pin to be turned and is motor driven. The weight of this machine is 80 pounds.

Tempering and Hardening Furnaces: C. U. Scott, Davenport, Ia. The tempering furnace is so designed that the heat can be held at any desired point for any length of time. The lead bath or crucible furnace is so arranged that it can be used for bluing or hardening as desired.

Drop Press: United Engineering & Foundry Co., Farmers' Bank Building, Pittsburg, Pa. Line of drop presses of the geared type, built in sizes ranging from 1000 to 3000 pounds, inclusive. When above 2000 pounds, cast-steel bases, lifter frames and extra-heavy cast-iron uprights are used in the construction.

Vertical Boring Mill: London Machine Tool Co., Ltd., Hamilton, Canada. Special design of vertical boring mill for turning elevator drums. A 3-horsepower variable-speed motor drives the boring spindle independently, while the table is driven by a 20-horsepower variable-speed motor, and it is provided with an electrical brake.

Quick-Acting Wrench: George W. Jessup, Jr., Newton, Mass. Wrench which may be quickly and conveniently adjusted to the desired size; if desired, it may be locked and used as an ordinary monkey wrench. A detachable pipe jaw, which when not in use may be kept in the hollow handle, makes it possible to grip pipe or other cylindrical work.

Trimming Press: United Engineering & Foundry Co., Farmers' Bank Building, Pittsburg, Pa. Trimming press designed to carry extra-long bed and slide and an extra-heavy side cut-off attachment. The main frame is bronze bushed and the clutches are equipped with steel jaws. This clutch mechanism is so arranged that the treadle can be reversed from front to back, when desired.

Locating Machine: Beacon Tool Works, Naugatuck, Conn. Machine for accurately and quickly locating centers on dies, jigs, templets or similar work, where accurate locating is essential. This machine is provided with micrometer adjustment, and it is accurately built throughout. Three sizes are manufactured, the smallest taking a block up to 4 inches square, and the largest one, 12 by 14 inches by 8 inches high.

Shop Stands, Racks and Vises: Western Tool & Mfg. Co., Springfield, O. Line of shop equipment including toolmakers' vise stand, portable shop stands and compact stock-rack. The vise stand permits the vise to be set to any convenient position, and, attached to the supporting column, there is a tray or shelf for holding tools. One of the shop stands is designed for use in connection with the lathes, while the other is mounted on wheels and can be employed for conveying parts about the shop.

Channeling Machine: Kane & Roach, Niagara and Shonnard Streets, Syracuse, N. Y. Machine for forming cold, flat stock into channels, half circles (as for tire rims) or into complete circles, or tubes. If desired, the metal can be turned out in a straight strip by equipping the machine with straightening rolls. When making automobile tire rims the flat bar is formed into the proper shape for the rim and bent into a circle in one operation, by using rolls of the proper shape and size. These machines are built for either belt or electric drive.

Electric Drill: New York Electric Tool Co., 136 Liberty St., New York City. Well-built portable electric drill that is driven by a substantial type of motor which transmits power through hardened steel and phosphor-bronze gears. The body of the drill is made of a soft, tough grade of steel, which is thoroughly annealed to offer high magnetic permeability for the motor fields. This casing also forms a strong protector for the working parts of the machine. Ball bearings are used throughout, and the drill has a capacity for holes up to ¾ inch in diameter in steel.

Adjustable Spring Collet: National Tool Co., Cleveland, O. Adjustable spring collet for automatic screw and turret machines. This collet is said to be non-breakable and it does away with the necessity of having a whole set of collets. It will grip all sizes of stock of either round, hexagon, square or octagonal shapes within its capacity. The full length of the jaws grips evenly on the stock, which is held true. These collets are made in seven sizes, the No. 1 size having a gripping capacity ranging from 1/16 to ½ inch, inclusive, and the No. 7 size, a capacity of from 2½ to 4 inches, inclusive.

Cam and Valve Grinder: Bay State Grinder Co., Worcester, Mass. Combination cam and valve grinder which is equipped with two wheels, one operating in connection with the cam grinding attachment and the other for valve grinding. If desired, however, two cam grinding or two valve grinding attachments may be used. Valves may be ground true by the stem and without using centers, though a special attachment for grinding them on centers is also made. When the machine is to be used for cam grinding, master cams are generated from approved models furnished by the customer. This machine is simple in construction and compactly designed.

Sensitive Drill Press: Albany Hardware Specialty Mfg. Co., Albany, Wis. Sensitive bench drill press in which power is transmitted from the driving pulley to the spindle by means of two friction wheels and a hemispherical plate. This plate is mounted on a pivoted support so that its position with relation to the wheels may be changed. As it is swung about its pivot, one of the friction wheels is continuously moving on a larger circle while the other is being moved to a smaller one, which causes variations in the spindle speed. Ten speeds are available and the lever which controls the hemispherical idler has an index-plate which shows the proper position for the lever for drills of different sizes operating in either cast iron, steel or brass. The machine is equipped with a depth gage, and also an adjustable stop so that a number of holes may be drilled to the same depth. This machine will drive drills up to ½ inch in diameter and it will drill to the center of a 12-inch circle.

Power Press: Walsh Press & Die Co., 4709-4711 W. Kinzie St., cor 47th Ave., Chicago, Ill. Special double-crank power press fitted with gang dies and automatic feed for the rapid production of drawn shells. These shells are approximately 2⅛ inches in diameter, with drawn edge or side of ⅜ inch. The number of dies in the gang is eight, and these cut, draw and emboss or letter the covers in one operation. The press proper is swung by trunnions at the front and it is supported in the rear by heavy upright adjustable jack screws which allow the machine to be inclined to suit the requirements of the work to be done. The feeding mechanism is so arranged that it places the sheet of tin automatically in the feed proper, thereby giving the operator ample time to adjust another sheet in place, making the production of these shells a continuous operation. As the press is run at a speed of 90 strokes per minute, and the dies produce eight covers at each stroke, it would, if run continuously for ten hours, have an output of 432,000 finished shells or covers. Allowing for reasonable stoppages, the builders claim that from 250,000 to 300,000 pieces such as described, or work of a similar character, can be produced in ten hours. This machine was designed by Mr. H. C. H. Walsh.

Horizontal Milling Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Heavy design of 50-inch horizontal milling machine which is convenient as to operation and capable of producing accurate work in quantity. The diameter of the spindle in the parallel bearings is 7 inches, and, in addition, there is a double taper bearing in front of the spindle sleeve, with a maximum diameter of 11 inches. The greatest distance between the spindle saddle and the outboard bearing is 51 inches; the minimum distance from the center of the spindle to the top of the work table, 5 inches, and the maximum, 31 inches. The spindle is arranged to drive a 4-inch cutter arbor by a broad key face. The spindle is driven by a 62-horsepower motor, which gives it a speed range of from 15.55 to 31.11 revolutions per minute. The work table has a spiral gear and rack drive, with three changes of feed for each of the spindle speeds. The spindle saddle and outboard bearing, in addition to having a convenient hand adjustment, may be elevated or lowered by an independent 3-horsepower motor, mounted on top of the housing. The outboard bearing also has an independent horizontal adjustment of 8 inches, in its saddle. All the gears on this machine are of hammered steel with teeth cut from the solid, with the exception of the worm-wheel by which the fast traverse is obtained, which is of Tobin bronze.

Engraving Machine: Keller Mechanical Engraving Co., 570 West Broadway, New York City. Motor-driven engraving machine for forming dies mechanically. This machine has two chucks, one of which holds the work and the other the pattern to be reproduced. Ordinarily, the pattern and work revolve at the same speed. A double-pivoted tool-arm which carries a stylus or pointer for following the form of the pattern and a cutting tool is fed across both pattern and work. In this way the cutter arm is given a movement by the guiding

point on the pattern, which reproduces the design of the pattern to a diminished scale on the die. The rotation of the work and pattern, as well as the motion of the tool-arm across the work, is comparatively slow, to insure more accurate detail. By means of a special governor the speed of the work is automatically reduced as the cutter travels toward the periphery. When sinking a die with this machine two cuts are ordinarily taken, one for roughing and the other for finishing. The patterns employed are usually made of hardened plaster or cast-bronze electros made from plaster molds. In addition to cutting dies for metal stamping, this machine can also be used for making coin or medal dies and other similar work, and the quality of the product turned out is said not only to rival, but to outclass that produced by the most skillful hand operators.

* * *

THE JOINT MECHANICAL ENGINEERS MEETING

The American flag flying over the Queen's Hotel in Birmingham, England, looked natural and proved a token of the more than generous welcome given by the British Institution of Mechanical Engineers and the city of Birmingham, to the visiting American engineers. The three days' meeting at Birmingham was crowded with receptions, luncheons, garden parties, excursions and entertainments of all kinds, but the various functions were arranged with true British system, so as to eliminate all confusion and crowding.

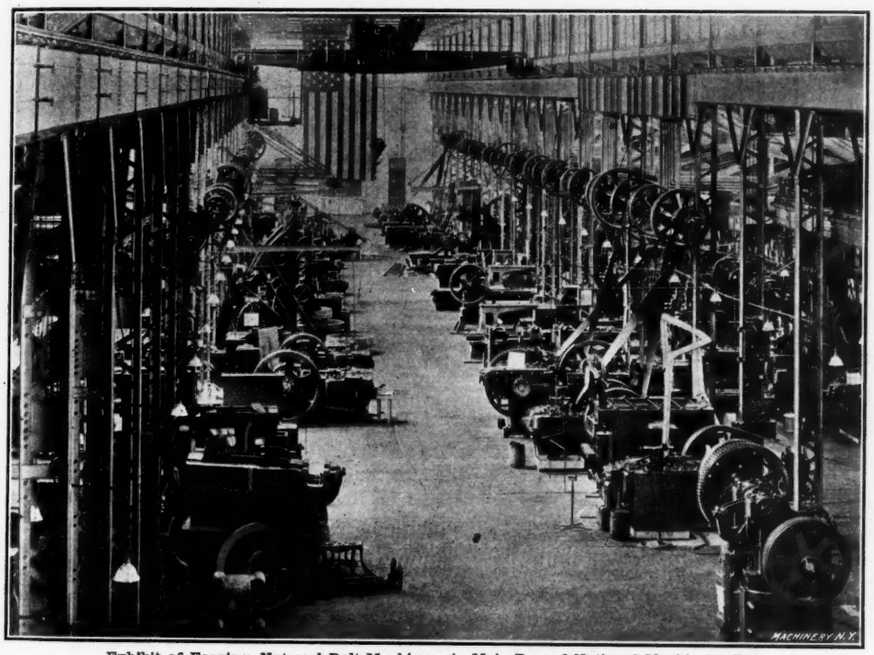


Exhibit of Forging, Nut and Bolt Machinery in Main Bay of National Machinery Co.'s Plant, Tiffin, Ohio, August 19-24

The official program was a folder of convenient size, comprising thirty-two printed pages and six excellent maps, one of the city of Birmingham, showing all the public buildings, and transportation lines, as well as the places where entertainments were to be given, and the others showing all the near-by points of interest, as well as the River Thames from Henley to Windsor. Within a short distance of Birmingham are Lichfield, Stratford-on-Avon, Kenilworth and Warwick, some of the most beautiful of England's show places; and excursions to all of these points were enjoyed by the members and guests. Some thirty individual works in Birmingham and vicinity also opened their doors to the visitors, and one of the most interesting of these was the machine tool works of Alfred Herbert, at Coventry, where American methods of manufacture adapted to British requirements are found in their perfection. The fourth and fifth days of the convention were spent in London and Windsor, and included a grand banquet.

The joint meeting was most successful in every way, and Mr. Calvin W. Rice, the secretary of the American Society of Mechanical Engineers, to whose efforts this result was largely due, is to be congratulated.

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN

The first meeting of the American Society of Engineer Draftsmen, embracing every branch of the profession, including mechanical, electrical, civil, architectural, marine, sanitary and automobile draftsmen, was held on July 27 in New York. The formation of this organization marks the first effort to form a national society among draftsmen. The need for such an organization has long been felt by the profession, both from an engineering and fraternal standpoint. The qualifications for membership are such that a standard will be established, and it is the aim of the society to maintain this standard and to secure recognition from concerns employing draftsmen. Mr. E. Farrington Chandler was elected president, Mr. William B. Harsel, vice-president, and Mr. Henry L. Sloan, secretary and treasurer. The headquarters are at 116 Nassau Street, New York City.

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DETROIT MEETING OF THE SOCIETY OF AUTOMOBILE ENGINEERS

The three-day meeting of the Society of Automobile Engineers held in Detroit, July 28-30, was an important event in the annals of the automobile industry. It brought together a large number of engineers who seek to cooperate in improving methods of manufacture and to harmonize discordant elements that are the natural result of an industry that has sprung up like a mushroom, in the night. Important advances have been made in the work of standardization and in preparation of standard reference tables for general practice. The society has a membership of about 400, and is growing rapidly.

Mr. Henry Souther, metallurgist of Hartford, Conn., and state chemist of Connecticut, gave an address entitled "The Specification and Heat Treatment of Automobile Material." Prof. R. C. Carpenter, of Cornell University, presented a paper by L. R. Evans, and R. P. Lay, entitled "A Test of a 20 H. P. Franklin Air Cooled Motor." Other papers were "Variations of Current Practice in Anti-Friction Bearings," by D. F. Graham, Bristol, Conn.; "Testing the Hardness of Metals," by A. F. Shore, of New York, and H. G. McComb, of Buffalo, N. Y.; "The Pyrometer—Its Development and Use," by W. H. Bristol.

The engineers visited a number of manufacturing plants, including the Aluminum Castings Co., Burroughs Adding Machine Co., Cadillac Motor Car Co., Chalmers Motor Co., Detroit Steel Products Co., E-M-F Co., Gear Grinding Machine Co., Packard Motor Car Co., Timken-Detroit Axle Co.

* * *

NATIONAL MACHINERY CO.'S EXHIBIT OF FORGING MACHINERY

About 250 delegates and ladies from the convention of the International Railroad Master Blacksmiths' Association at Detroit, left Friday morning, August 19, by special train, for Tiffin, Ohio, where they were guests of the National Machinery Co., who had on exhibition a complete line of forging machines, thread rollers, bolt cutters and other products of their big plant. While the blacksmiths were inspecting the machine exhibits, entertainment was provided for the ladies at one of the local parks. Both dinner and supper were served to the visitors, after which a special train took them back to Detroit. The National Machinery Co. is to be congratulated on the manner in which the event was managed.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION CONVENTION

The eighteenth annual convention of the International Railroad Master Blacksmiths' Association opened at the Hotel Cadillac, Detroit, Mich., August 16, with President George W. Kelley in the chair, and with an unusually large number of members in attendance. Papers were read on tools and formers, frame welding, the oxy-acetelyne welding process, spring making, casehardening and several other subjects, all of which were discussed, the members giving their personal experiences and opinions thereon.

About twenty-five supply dealers had exhibits and furnished an interesting program of entertainments, including automobile, trolley and boat rides, and a final complimentary excursion by the National Machinery Co., by special train, to Tiffin, Ohio.

At the close of the morning session, August 18, the following officers were elected for the ensuing year: John Conners, A. & W. P. R. R., Montgomery, Alabama, president; F. F. Hoeffle, L. & N. R. R., Louisville, Ky., first vice-president; J. T. McSweeney, B. & O. R. R., Baltimore, Md., second vice-president; A. L. Woodworth, C. H. & D. R. R., Lima, Ohio, secretary and treasurer, and G. H. Williams, Boston, Mass., chemist, after which the convention was adjourned, instructions being given to the executive committee to select the next meeting place from the cities of Toledo, Boston or Denver.

* * *

SIXTY YEARS SERVICE WITH ONE COMPANY

Thomas Ogram who has been employed by William Sellers & Co., Inc., for over sixty years

At a time when employers are troubled by the unreliability of employes and the difficulty of holding them in continuous faithful service, as probably never before, it is refreshing to hear of the long, honorable career of Mr. Thomas Ogram with William Sellers & Co., Inc., of Philadelphia. On July 23 Mr. Ogram completed a term of sixty years' service with the company which he has served as apprentice, journeyman-machinist, foreman, instructor, counsellor of apprentices, and in the doing of which he won the respect and regard of all with whom he came in contact. While not now in active service, he is still on the payroll of the company and is regarded as one of them.

The completion of the sixtieth year was fittingly celebrated by a reception at which the men in the shops and the officers of the company, some of whom had been in service with him for nearly fifty years, greeted Mr. Ogram. An engrossed album testimonial, signed by the officers and staff and the directors who were formerly officers and long associated with Mr. Ogram, was presented to him, after which a collation was served. The testimonial follows:

To our dear comrade, Thomas Ogram, greeting:

This twenty-third day of July, nineteen hundred and ten, brings to us the notable reminder that on the same day many years ago you entered the employ of this house as an apprentice, and have now completed an unbroken, faithful and honorable service of sixty years.

It is accorded few men to attain such an enviable record, and fewer employers to receive such loyal service.

In all of this long period as apprentice, journeyman-machinist, foreman, and trusty counsellor and instructor of other apprentices, your varied and responsible duties were performed cheerfully and with exceptional skill, while the impress of your high character and genial personality was left upon all with whom you came in contact.

Meanwhile the number of our employes grew from thirty-five to nearly six hundred, and the product of the particular department with which you were most directly identified—metal planing and metal planing machines—has acquired the highest reputation all over the world.

It therefore seems to us fitting that we should especially commemorate this day by presenting to you with appreciative and affectionate greeting, this inscribed testimonial as a permanent record of our high and lasting regard.

It is interesting to reflect on the changes in manufacturing conditions and in the industrial world generally that have come about in the span of Mr. Ogram's industrial career, beginning 1850, but of greater present interest is the consistent policy of a manufacturing concern that won and held the loyalty of an employe for sixty years. May there not be in this example of harmonious relation extending over an ordinary lifetime a suggestion for those who deplore the never-ending conflict between capital and labor?

* * *

LOW SALARIES OF ENGINEERS IN GERMANY

An interesting article in *Teknisk Tidskrift* calls attention to the over-supply of technically educated men in the German industries and the resulting low wages paid to well-educated men filling the positions in the designing room and laboratory. A young man, after having finished a four or five years' college course, often finds himself forced to accept a position with no pay at all for four or six months, with the promise that after that time his services will be compensated, providing he proves satisfactory. Others receive from $10 up a month, and a young graduate who receives 100 marks ($25) per month considers himself fortunate. It is by no means only for the first few years that the technical graduate finds himself so poorly compensated. There is a large class of these men whose salary never exceeds 200 marks ($50) per month. The same scale of compensation applies also to the great number of doctors of philosophy who have entered in industrial work as chemists. A monthly pay of 175 marks ($45) per month for a middle-aged doctor working in the laboratories of the large industrial companies is not unusual. These conditions are due to the enormous number of men who have, during the last few years, entered into industrial work. During the fifteen years from 1891 to 1906 the number of students at the higher engineering schools in Germany increased over 200 per cent, and is still increasing, while at the same time the number of students at the regular universities who devoted themselves to sciences and of which the majority later on entered the industrial field, increased by 160 per cent. The number of students at the lower technical colleges during the same period increased by 130 up to 300 per cent. The conditions have become so acute that the Bavarian Government has issued a warning to young men against selecting the engineering profession on account of the over-supply of men in this branch.

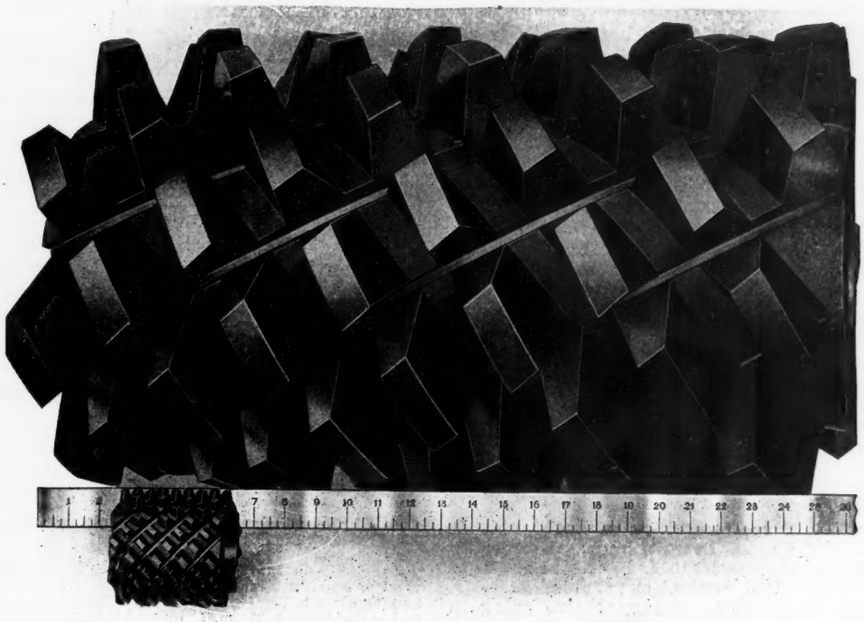
These abnormal conditions have also created a system of industrial despotism unknown in America. It is not unusual that the young graduate in order to obtain a position is required to sign a contract in which he agrees that he will not enter into the employ of a competing firm during a period of from two to four years, or, in extreme cases, up to ten years, after the time of leaving the employer with whom this contract is made. The older employes are largely tied to their position by the pension system of the employers. Another abnormal condition which may be mentioned is that an employe has no right to patent anything that has been conceived in connection with his employment, and the inventions which he makes are the property of his employer. His name, in fact, does not even appear in the patent application. In many cases access to the works is entirely denied any employe not directly working in the shops, and sometimes one will hear persons expressing their wish to see the works where for a period of five years they may have been working in the drafting-room or laboratory.

* * *

COBALT-CHROMIUM ALLOY TO REPLACE STEEL IN MAKING CUTLERY

A new alloy, discovered by Elwood Haynes, an automobile manufacturer of Kokomo, Ind., is proposed as a substitute for steel in the manufacture of small cutlery. It is more lasting than steel and so slightly higher in cost that it will be a practical metal for that purpose. Mr. Haynes has erected a factory in Kokomo for the manufacture of cutlery in the new alloy, which is a compound of cobalt and chromium. When a mixture of cobalt and chromium is heated to whiteness in a crucible the cobalt fuses first and immediately combines

When you buy a hob that is accurately cut, properly hardened and correctly ground, you can feel sure of accurately cut worm wheels.



HOB MANUFACTURE

Because of our long experience, coupled with the aid of special hobbing machinery, we are able to fulfill all of the above conditions and to quickly fill all orders for Worm Hobs, either large or small.

The main characteristics of these hobs are their accuracy, ability to stand up under heavy service and the fact that they cut as freely and may be sharpened in the same manner as formed cutters.

The illustration shows the comparison between a small hob and a large one 25⅜″ in length, 15.4″ in diameter, 28″ lead, 7 threads and 4″ circular pitch.

The hobs are made with straight or taper holes, right or left hand threads and with or without shanks.

We will gladly estimate and submit prices on hobs if you will submit blue prints of the work you wish to do.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

with the chromium; if the metals are mixed in the proportion of about three parts, by weight, of cobalt to one part of chromium, a eutectic is formed, that is, an alloy having a lower melting point than cobalt or chromium. The color of the alloy lies between that of steel and silver and is especially pleasing in a bright light. It is readily polished, but requires special treatment in order to develop its highest luster. The most valuable property of this combination, however, is its resistance to corrosion. It is equalled in this respect only by gold and metals of the platinum group. It is attacked slowly by cold hydrochloric acid, and somewhat vigorously by the strong acid when heated. Momentary exposure, however, to either dilute or strong hydrochloric acid has practically no effect upon the metal. Fruit acids which quickly dim the luster of ordinary cutlery do not tarnish the cobalt-chromium alloy.

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PERSONALS

T. Evans, for many years purchasing agent of the Cananea Copper Co., has been appointed local manager of the Mine & Smelters Supply Co.'s branch office at Denver.

C. M. Hamersly, formerly engineer with the Link Belt Co., Philadelphia, is now in charge of the Philadelphia office of the Vandyck Churchill Co., 654 Bourse Building, Philadelphia, Pa.

George Gilmore, head of the safety department of the Travelers' Insurance Co., New York, has been sent to Europe by the New York State sub-committee on industrial accidents to study the causes of industrial accidents in England, Germany, France and Switzerland.

G. A. Thompson, for a number of years special traveling representative of the Lodge & Shipley Machine Tool Co., has entered the employ of that firm's Pittsburg agent, the Brown & Zortman Machinery Co., as a general machine tool salesman in the Pittsburg district.

Walter Cantelo has resigned his position as superintendent of the Herreshoff Motor Co., of Detroit, Mich., in order to enter into the employ of the American & British Mfg. Co. of Bridgeport, Conn., as assistant general superintendent. Mr. Cantelo was connected with this company before going to Detroit nearly two years ago.

Frank Koester, of New York, in a paper presented before the recent convention of the Society for the Promotion of Engineering Education, held at Madison, Wis., discussed in detail the educational system of the German Technical Universities. He also analyzed the conditions and standing of the German engineers as compared with our own.

M. A. Beck, who was chief engineer of the Pawling & Harnischfeger Co. for a number of years and who has been closely connected with the design and manufacture of cranes, machine tools, etc., for years, has allied himself with the Toledo-Massillon Bridge Co., Toledo, Ohio, in the capacity of consulting engineer and representative in the Milwaukee district.

William J. A. Bailey, 32 Broadway, New York City, who recently returned from a successful trip around the world, representing a number of American manufacturers, is now preparing for another business tour, and expects to leave this country early in the Fall. He expects to be gone about a year, visiting the leading commercial centers of the world, and his trip will no doubt be of interest to manufacturers seeking foreign trade.

Dr. William H. Tolman, director of the American Museum of Safety and chairman of the American Executive Committee of the International Committee of Social Insurance, has been designated by the State Department at Washington as a delegate on the part of the United States to the International Congress on Workmen's Insurance to be held at the Hague, September 6-9. Among the questions to be discussed are: the extension of social insurance to include other than workmen, that is, small trades-people, shop keepers, and farmers; provisions for widows and orphans by insurance; and insurance against unemployment.

Prof. George I. Alden, treasurer of the Norton Co., Worcester, Mass., returned, on July 29, from a short business trip to England and Germany. The Norton Co. has established at Wesserling, Germany, a plant for making abrasive wheels, and Prof. Alden visited the new plant in the interests of the firm with which he is officially connected. He was accompanied on his return voyage by Mr. Clayton O. Smith, chief of the purchasing department for the Norton Grinding Co. Mr. Smith was returning from a trip of about seven weeks' duration to the Continent and to England, during which he had visited the cities of London, Berlin and Paris, as well as other cities in which are agencies and stores of the Norton Grinding Co.

OBITUARIES

Albert H. Wheeler, president of the Standard Machinery Co., Mystic, Conn., died August 4.

Charles W. Fisher, a member of the W. P. Davis Machine Co., Rochester, N. Y., died July 21 at his home in Rochester, aged fifty-one years.

David Ranken, Jr., founder of the School of Mechanical Trades in St. Louis, which bears his name, died at Atlantic City, N. J., August 18, aged seventy-four years.

Albert Spies, for several years editor of *Cassier's Magazine*, and later proprietor and editor of the *Foundry News* (recently founded), died at his home in Jersey City, N. J., August 16, aged forty-eight years.

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COMING EVENTS

September 6-9.—Fifteenth annual convention of the International Association of Municipal Electricians, Rochester, N. Y.

September 15-17.—Semi-annual meeting of the National Association of Cotton Manufacturers, Portsmouth, N. H., Hotel Wentworth, headquarters. C. J. H. Woodbury, secretary, 45 Milk St., Boston, Mass.

October 9-12.—Second International Congress of Refrigeration, Vienna, Austria. For further information address Mr. F. W. Pilsbury, 1660 Monadnock Building, Chicago, Ill.

October 10-14.—Annual convention of the American Street and Interurban Railway Association, Atlantic City, N. J. H. C. Donecker, secretary and treasurer, 29 West 39th St., New York.

November 17-19.—Fourth annual convention of the National Society for the Promotion of Industrial Education, Boston, Mass. A feature of this convention will be a lecture on "Continuation Schools," by Dr. George Kerschensteiner, superintendent of schools, Munich, Germany.

SOCIETIES AND COLLEGES

EIGHTEENTH ANNUAL CATALOGUE, UNIVERSITY OF IDAHO, Moscow, Idaho.

YEAR BOOK OF THE MICHIGAN COLLEGE OF MINES, Houghton, Mich. Frances H. Scott, secretary.

COLUMBIA UNIVERSITY BULLETIN OF INFORMATION ON SCHOOLS OF MINES, ENGINEERING AND CHEMISTRY, New York. Frank D. Fackenthal, secretary.

BULLETIN OF THE UNIVERSITY OF NEBRASKA. 462 pages, 5¾ x 8½ inches. Published by the University of Nebraska, Lincoln, Neb.

This bulletin is the fortieth annual general catalogue of the university, and contains a complete record for the year 1909-1910 and announcements for 1910-1911. The courses of instruction are outlined and considerable general information regarding the university is given.

BULLETIN OF THE UNIVERSITY OF UTAH. 286 pages, 5 x 7½ inches. Published by the University of Utah, Salt Lake City, Utah.

This catalogue contains announcements for the year 1910-1911, together with a list of students for 1909-1910. It gives complete information regarding the university, its rules and regulations, courses, fees and expenses.

AMERICAN ASSOCIATION FOR LABOR LEGISLATION, Metropolitan Tower, 1 Madison Ave., New York City. Papers read at the First National Conference on Industrial Diseases, Chicago, June 10, 1910. This pamphlet of 52 pages, 6 x 9 inches, contains several important papers relating to diseases prevalent among industrial workers due to their occupation.

AMERICAN ASSOCIATION OF COMMERCE AND TRADE, Equitable Building, Friedrichstrasse 59-60, Berlin, Germany, founded seven years ago by Americans, for the purpose of promoting American trade with Germany and German trade with the United States, calls the attention of American business men, intending to do business in Germany, to the facilities of the association. Information is given regarding business conditions in Germany, and firms are actively assisted in finding agents and establishing branches in Germany.

NEW BOOKS AND PAMPHLETS

THE FORESTS OF ALASKA. By R. S. Kellogg. 24 pages, 6 x 9 inches. Illustrated with maps and halftones. Published by the Department of Agriculture, Washington, D. C.

THE NEW YORK IMPROVEMENT AND TUNNEL EXTENSION OF THE PENNSYLVANIA RAILROAD. 31 pages, 5½ x 8 inches. Illustrated. Published by the Pennsylvania R. R. Co., Philadelphia, Pa.

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1908. 999 pages, 6 x 9 inches. Published by the Interstate Commerce Commission, Washington, D. C.

BULLETIN OF REVENUES AND EXPENSES OF STEAM ROADS IN THE UNITED STATES FOR THE MONTH OF APRIL, 1910. 19 pages, 9½ x 11½ inches. Published by the Interstate Commerce Commission, Washington, D. C.

INTERNATIONAL UNION OF THE AMERICAN REPUBLICS. Report of the Director to the Fourth Pan-American Conference held at Buenos Aires, Argentine Republic, July, 1910. 120 pages, 6 x 9 inches. Published by the International Bureau of the American Republic, Washington, D. C.

ENGINEERING RECORD DIRECTORY. 131 pages, 4 x 7 inches. Published by the *Engineering Record*, New York.

This is a directory of manufacturers of and dealers in engineers' and contractors' machinery and supplies. The directory is not intended to be a complete directory of the trade, the names listed being limited to those concerns and individuals whose advertisements appeared in the contractors' number of the *Engineering Record*, April 2, 1910.

DIMENSIONS OF PIPE FITTINGS AND VALVES. 89 pages, 6 x 9 inches. Published by the National Book Co., Collinwood, Ohio. Price $0.75.

This book, which is now in its third edition, contains a collection of such dimensions and information as will enable the draftsman, engineer or architect, to plan installations including pipes, fittings and valves. Some of the tables have been taken wholly or in part from trade catalogues and engineering publications, proper credit having been given. A great many of the tables have been obtained by actual

The New Cincinnati Cone Driven Miller

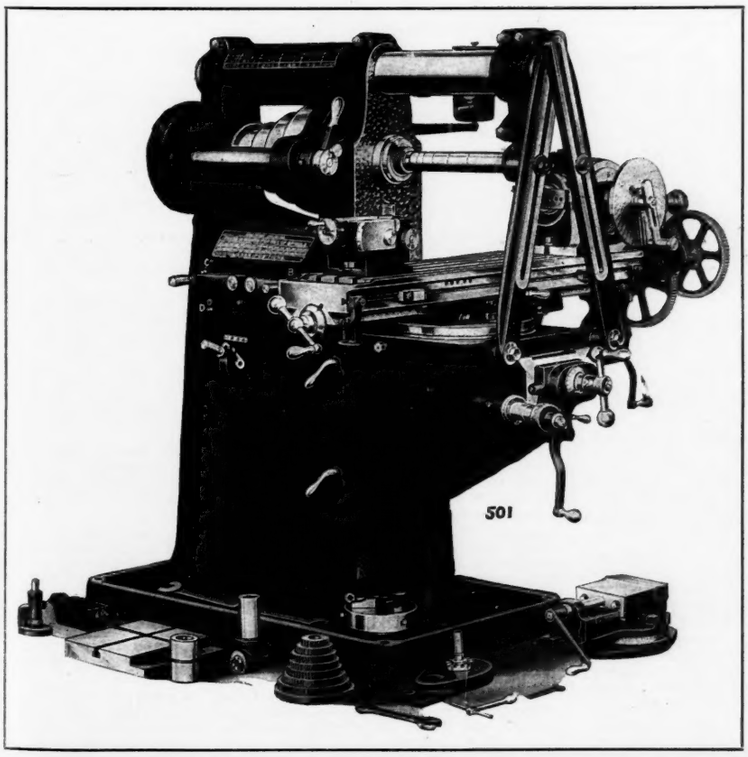
IN every shop there is some work on which the cutting is light that can be milled to best advantage on a modern Cone-driven Machine. To meet such requirements we have redesigned our line of Cone Type Millers, Plain and Universal. They have many important features far in advance of other Cone-driven Millers.

The COLUMN is a complete box of rectangular form.

The FEED MECHANISM is a single unit, assembled complete by men who are specialists on this work. When in place, it is an integral part of the machine. It is located high above the floor—the operator need not stoop to reach the levers. The feed changes may be made within the practical limits of milling while taking a cut, without inconvenience or injury to the gears, because they all run at moderate speeds.

The FEED INDEX is direct-reading—no chance for confusion, or doubt as to the proper lever movements. It is the simplest index used on any machine tool.

All these features make this type the ideal machine for manufacturing small parts and for tool-room use.



We make a complete line of newly designed Millers; Plain, Universal, Vertical — Cone-driven, High Power.

Ask for our Catalog.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO
U. S. A.

measurement. Many corrections and additions have been made in the third edition in order to enhance the value of the book.

SHOP MATHEMATICS. By Edward E. Holton. 211 pages, 4¾ x 7¼ inches. Published by the Taylor-Holden Co., Springfield, Mass. Price $1.25.

This book is the result of twelve years' experience on the part of the author as draftsman and shop foreman, combined with an equal length of service as instructor in day and evening classes in technical and trade schools. The main feature of the book is the collection of practical shop problems, most of them being actual problems which have arisen in the author's own experience, and were collected specifically for use in his own classes. The author is now at the head of the department of Machine Shop Practice at the technical high school of Springfield, and hence is eminently fitted, as an educator as well as a practical man, to produce a book of this kind. The book gives evidence of careful preparation, and contains a multiplicity of matter presented in a simple manner. The problems are of the most varied character and are given in sufficient number to insure that the principles on which they are based will be thoroughly digested by the student. Of the extensive contents of the book the following heads may be mentioned: Mechanical Powers, Screw Threads, Spur Gears, Bevel Gears, Worm Gears, Spiral Gears, Pulleys, Friction, Leather Belting, Manila Ropes, Chain Transmission, Shafting, Journal Bearings, Ball Bearings, Calculations Relating to Machine Tools, Hammer Blow, Horsepower of Machines, Flywheels, Power of Steam Engines, Engine Cylinders, Steam Boilers, Hydraulics, the Metric System, and a valuable collection of formulas. Answers to the various problems are given at the back of the book, together with a general index.

CATALOGUES AND CIRCULARS

J. E. RHOADS & SONS, 40 Fulton St., New York City. Blotter advertising Tannate round belting.

BRIGHTMAN MFG. CO., Shelby, Ohio. Price list of finished round, square, hexagon, and flat machinery steel.

J. E. RHOADS & SONS, 40 Fulton St., New York City. Booklet advertising Rhoads leather belting for different services.

ACHESON OILDAG CO., Niagara Falls, N. Y. Leaflet advertising the new lubricant Oildag and calling attention to its advantages.

KINETIC ENGINEERING CO., Baltimore Ave. and 60th St., Philadelphia, Pa. Pamphlet advertising the Kinetic organ blower.

CLINTON E. WOODS, Industrial and Commercial Engineer, 27 East 22nd St., New York City. Bulletin on industrial engineering.

AMERICAN ASSOCIATION OF COMMERCE AND TRADE, Friedrichstrasse 59-60, Berlin, Germany. Semi-monthly bulletin, Volume 8, No. 3.

DIAMOND ELECTRIC CO., Binghamton, N. Y. Leaflet on Delco electrically heated glue pots, giving a brief description and prices.

MILLED SCREW & MACHINE CO., Sayre, Pa. Circular describing the improved automatic universal thread milling machine made by the company.

UNION TWIST DRILL CO., Athol, Mass. Leaflet advertising high-speed steel drills. Folder advertising carbon and high-speed steel milling cutters.

VANDYCK CHURCHILL CO., 91-93 Liberty St., New York City. Folder advertising the White Star oil filter. The capacity of various sizes of filters and their prices are given.

R. F. LANG, 31-33 Broadway, New York. Circular advertising Atlas lead cement used instead of lead in anchoring machinery, calking pipe joints and for other purposes.

ACME ROAD MACHINERY CO., Frankfort, N. Y. Catalogue No. 8 of road building machinery, contractors' supplies, oil sprinklers, street sweepers, water sprinklers, pumps, traction engines, boilers, etc.

DODGE MFG. CO., Mishawaka, Indiana. Official program of the annual outing of the Dodge employes, held at Winona Lake, Indiana, July 30, 1910. Over 2,000 persons participated in this outing.

DODGE MFG. CO., Mishawaka, Ind. Folder entitled "Saving Fuel," calling attention to the advantages of the Dodge Eureka water softener and purifier. The folder explains the construction of the device in detail.

In the catalogue and circular notes in the August, 1910, issue of MACHINERY, the address of the Russell Jennings Mfg. Co. was erroneously given as Port Chester, N. Y., whereas it should have been Chester, Conn.

WALTON CO., Hartford, Conn. Circular illustrating and describing the Walton tap extractor for removing broken taps from tapped holes. This extractor is made in 16 sizes covering No. 8 to 1¼-inch taps, inclusive.

BONNEY VISE & TOOL WORKS, INC., Allentown, Pa. Catalogue No. 15 of drop-forged wrenches of a great variety of types and sizes. Detailed dimensions are given, together with complete price-list of all the wrenches shown.

UNDER-FEED STOKER CO. OF AMERICA, Marquette Bldg., Chicago, Ill. Advertising pamphlet entitled *The Publicity Magazine*, devoted to the interests of the Jones stoker. This pamphlet contains considerable matter of interest to steam engineers.

IDEAL ELECTRIC & MFG. CO., Mansfield, Ohio. Bulletin 1051 entitled "Revolving Field Alternators." The bulletin not only gives the details of construction of a new line of alternators, but also test curves and data showing their performance under various conditions.

CUSHMAN CHUCK CO., Hartford, Conn. Condensed 1910 catalogue and price list of Cushman chucks and faceplate jaws, including independent four-jaw chucks, geared scroll chucks, special chucks for cutting-off machines, two-jaw chucks, drill chucks and drill chuck arbors.

ATELIERS JASPAR, SOCIETE ANONYME, Liége, Belgium. Catalogue of machine tools, including planers, shapers and gear cutting machinery. Also catalogues of hand milling machines, plain and universal milling machines, Lincoln milling machines, gun barrel drilling machines, etc.

GEORGE H. GIBSON CO., Tribune Building, New York. Pamphlet entitled "How to Reduce the Expense of Selling Machinery." This pamphlet describes improved methods for promoting the sale of machinery by means of educational work and advertising. Hints are given concerning the writing of circulars, catalogues and advertisements.

A. A. JONES, POLLARD & SHIPMAN, LTD., Leicester, England. Circulars of New Century 20-inch heavy pattern drill and 26-inch upright back-geared drill, together with description of sensitive radial drilling machine and 26-inch high-speed all-geared drilling machine, these latter descriptions being reprinted from *Engineering*, of London.

LE PROGRES INDUSTRIEL, SOCIETE ANONYME, Loth pres Brussels, Belgium. Catalogue of machine tools, principally engine lathes of various descriptions, as well as turret lathes and hand screw machines. The catalogue is well printed and provided with handsome illustrations. It contains a number of useful tables and collections of formulas for calculations likely to occur in the machine shop and drafting-room.

E. C. ATKINS & CO., Inc., Indianapolis, Ind. Catalogue of Atkins metal saws containing complete price-list of cold cutting-off and slitting saws for metal, circular saws for cutting hot or cold metal, hollow ground circular metal saws made of high-speed steel, circular saws made for special machines, hack-saw blades, hack-saws, and the Atkins "Kwik Kut" power hack-saw machine.

W. S. ROCKWELL CO., 50 Church St., New York. Circular of the Rockwell spring fitting furnace for oil or gas fuel. This furnace, which is especially designed for manufacturers of steel springs, heats the spring steel stock uniformly and cleanly. No blast or flame impinges directly on the steel, the steel being always completely enveloped by a vapor which prevents oxidization.

R. G. PETERS MFG. CO., Grand Rapids, Mich. Bulletin No. 101 illustrating and describing a locomotive electric headlight outfit consisting of a turbine generator, electric arc lamp, lamp reflector, lamp casing and supplies for cab wiring. The turbine generator is 29 inches long, 18 inches wide, 20 inches high and weighs 325 pounds. The steam consumption is 225 pounds per kilowatt hour, the generator output averaging about 1 kilowatt.

C. H. DRIVER, Racine, Wis. Circular of "Wonder" sander which may be used as a reciprocating belt or surface sander or as a reciprocating spindle sander. In use, the sanding surface reciprocates as it revolves, the object being to overcome circular marks made by sanding with the revolving faceplate and the wavy marks made by the use of a drum or roller. These sanders, while designed primarily for wood work, are used to some extent in metal-working shops for buffing and polishing.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4760, illustrating and describing a line of direct current instruments for switchboard use. Bulletin No. 4750 describing standard couplings adapted for coupling electrical apparatus together, or to other machinery. Bulletin No. 4718, illustrating and describing all of the apparatus required for a complete series incandescent lighting system. Bulletin No. 4752 illustrating and describing rectifier sets, luminous arc lamps and all necessary auxiliary apparatus for complete series luminous arc rectifier systems.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4756 giving a graphic description of the ventilation of horizontal steam turbine alternators. Bulletin No. 4753 describing the General Electric Mazda 400- and 500-watt incandescent lamps for standard lighting service. This bulletin contains data regarding cost of lamps and service at various voltages. Bulletin No. 4751 describing polyphase induction motors. Bulletin No. 3968 describing electric cooking apparatus for hotels and restaurants. Bulletin No. 4743 describing intensified arc lamps; the principal characteristics of these lamps are their high efficiency and the daylight quality of the light.

W. A. JONES FOUNDRY & MACHINE CO., North Ave. and Noble Sts., Chicago, Ill. Catalogue No. A18 of power transmission appliances and machinery and elevating and conveying machinery for handling materials. It lists heavy flywheels, cone pulleys, machine molded pulleys, wood split pulleys, friction clutches, cut-off couplings, tension carriages, rope sheaves, spur gears, bevel gears, worm gears, sprocket wheels, traction wheels, shafting, friction couplings, hangers, universal couplings, floor stands, belt tighteners, spiral steel conveyors, friction hoists, hand derrick winches, capstans, emery grinders, floor grinders, countershafts, oil engines, gas engines, etc.

YALE & TOWNE MFG. CO., New York and Stamford, Conn. Loose-leaf catalogue of locks and hardware, bound in green cloth with red leather back and corners with gold edges. The catalogue contains upward of 900 pages and 4000 new illustrations. The contents are: introductory section, customary index and brief interesting articles regarding padlocks, locks and latches, door checks, miscellaneous hardware arranged by schools, and cabinet and trunk locks. The new Yale & Towne turret locks especially constructed for use on fire-proof doors are described and illustrated. Monotype composition was used throughout and no vertical and horizontal rules were employed. The catalogue is a fine specimen of typographical art and a credit to the Yale & Towne Mfg. Co.

TRADE NOTES

PEERLESS V-BELT CO., Chicago, Ill., manufacturer of power and transmission machinery, has removed from South Clinton St. to 547 West Jackson Boulevard.

JOHN WILEY & SONS, 43-45 East 19th St., New York, announce that a new edition of Kent's "Mechanical Engineers' Pocket Book," rewritten and re-set, will be ready during the month of September.

C. H. HUGHES & CO., ENGINEERS, have, owing to increasing business in developing and investigating mechanical and electrical devices, moved from 115 Broadway to larger offices at 64 Wall St., New York.

FOOS GAS ENGINE CO., Springfield, Ohio, is considering the erection of a large factory addition in order to take care of its greatly increased business, as it is found impossible at the present time for a double force of men to meet the orders of the company.

W. VON DENFFER, Swetschnoi, Pereulok No. 3, St. Petersburg, Russia, representing American high-grade machine tools in Russia, desires to get in touch with manufacturers of pipe drawing machinery who make steel pipe up to 122¾ millimeters outside diameter.

CHICAGO RAWHIDE CO., Chicago, Ill., has erected a large up-to-date factory at 1301 Elston Ave., replacing its plant on Ohio St. destroyed by fire some months ago. The new plant will largely increase its capacity. Mr. John T. Emery now has full management of the business.

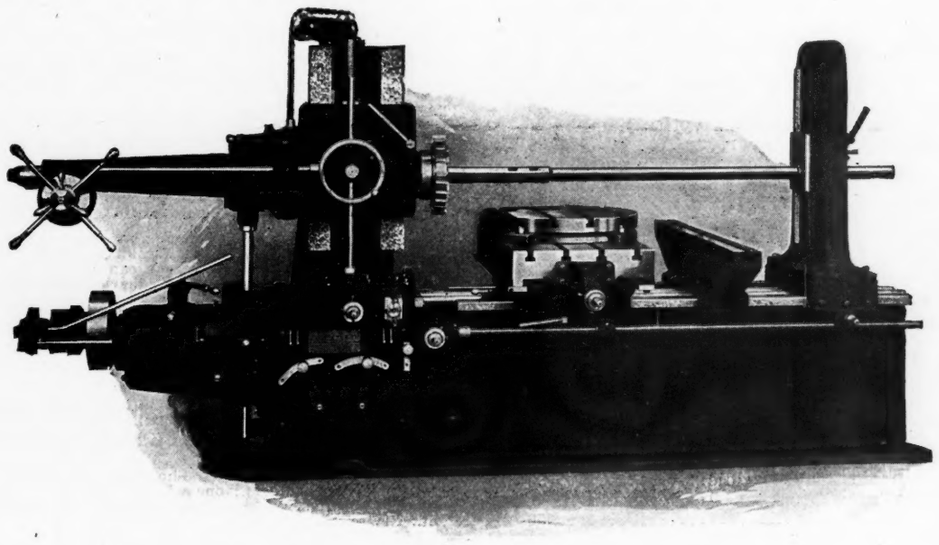
PH. BONVILLAIN & E. RONCERAY, 9-11 Rue des Envierges, Paris, France, have purchased back from the E. H. Mumford Co. the patent rights for their universal molding machines and pattern system, and are now in a position to make arrangements with some American firm in relation to these patent rights.

MILLED SCREW & MACHINE CO., Sayre, Pa., manufacturer of screw thread milling machines, is now fully equipped to manufacture screws and worms for the trade. The company makes a specialty of cutting long, coarse-pitch screws and worms of large diameter. It can cut screws up to 40 feet or even 50 feet long.

UNION TWIST DRILL CO., Athol, Mass., is making an addition to its factory, 141 feet long and 62 feet wide, four stories high. This building will be used as an extension to the drill manufacturing department. A one-story building is also added to the hardening department, the addition being 51 feet long by 32 feet wide.

DEPARTMENT OF COMMERCE AND LABOR is about to issue an International Trade Directory containing about 125,000 names of individuals and firms in foreign countries actively engaged in foreign trade. The price will be $5.00 per copy. Those desiring copies should send their orders promptly to the Bureau of Manufactures, Washing-

"Excellent Service is the Wisest of Salesmen"



THE

"PRECISION"

BORING, DRILLING AND MILLING MACHINE

is designed and made so it gives

EXCELLENT SERVICE

We feel that we CANNOT AFFORD to make it any other way, so you are SAFE when you order one.

Lucas Machine Tool Co., (NOW AND ALWAYS OF) Cleveland, Ohio., U.S.A.

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan.

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ton, D. C., in order that the number of copies to be printed may be determined.

RACINE TOOL & MACHINE CO., Racine Junction, Wis., manufacturer of Racine high-speed power hack-saws, is erecting a two-story modern shop building not far from its present location. The popularity of this hack-saw has made the demand such that the present quarters are entirely too small. The new building will give the company about twelve times the present floor space, and will be equipped with up-to-date machinery throughout.

WELLS BROS. CO., Greenfield, Mass., is sending the foremen of its various departments and their families on outings during the summer months. These outings take the form of all-day automobile trips through the surrounding country-side, which is particularly beautiful, just now, and to the nearby cities and towns. One or two of the foremen with their families are sent at each time, the company providing a big Jackson touring car and paying all expenses. Each trip is about 125 miles, the start being made early in the morning and the return ride early in the evening. Dinner is arranged for at one of the hotels at the point of destination.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

AGENTS IN EVERY SHOP WANTED to sell my sliding Calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

AGENTS wanted in every works in Great Britain where draftsmen, machinists and tool-makers are employed, to represent MACHINERY and take orders for MACHINERY'S remarkably successful Reference Books. Special offers in force in Great Britain for a limited time only, give a choice of 60 Reference Books sold at a shilling per copy, and a subscription for MACHINERY, cash or *credit*. No charge is made for credit. We supply sample copies and advertising matter describing the books in detail for distribution in Engineering Works. Write us for full information. WM. DAWSON & SONS, LTD., Cannon House, Bream's Bldgs., London, E. C.

CONCERN with well equipped plant for light manufacturing, wants to hear from parties with established business, desirous of enlarging their facilities and reducing their expenses for rents, etc. Our plant is well located, cheap power, fuel, and labor. R. R. SIDING, Cadiz Stamping Works, Cadiz, Ohio.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

DRAWINGS, TRACINGS, ETC., MADE.—Prices reasonable. Box 1302, Orange, Mass.

FORMULAS AND TABLES FOR SHOP AND DRAFTING ROOM is No. 35 in MACHINERY'S Reference Series, and for practical use in mechanical work is undoubtedly the most widely technical useful book published in years. Send for free pamphlet with new offers. Address MACHINERY, 49 Lafayette St., New York.

FOR SALE at a bargain, two Brownell 60'x16' boilers, one Erie 60'x16' boiler, two Brownell engines 11"x12", speed 350 R.P.M., one Hoppes Feed Water Heater, one Air Compressor, 10"x12", motor driver and geared, all in excellent condition. Address for particulars, W. A. VOSS, Rapid Motor Vehicle Co., Pontiac, Mich.

FOR SALE.—Bargain, Electric motor, 20 horse. Wagner, alternating 60 cycles single phase, 220 volts complete with starter, almost new. IMPERIAL MACHINE CO., 261 Elm St., Newark, N. J.

ITALY.—WANTED AGENCY of large American firm that wishes to begin or develop important business in Italy. Good occasion Universal Exhibition Turin 1911 (Office 41 Union Square, Room 1014, New York). BERNOULLI & CABIBI, Turin. House founded 1878. First-class references in United States.

MACHINISTS WANTED.—Men experienced at assembling the mechanism of crane bridges. Address box 183, Detroit, Mich.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. Trade-marks registered.

SHARPEN your tools with Carborundum Stone in Patent Holder. Stone and Holder mailed for 50 cents. F. J. BADGE, 286 Taaffe Place, Brooklyn, N. Y.

THE "Gas Saver" Brazing Forge. Circular. J. L. LUCAS & SON, 2 Fox St., Bridgeport, Ct.

TO REPRESENT YOU IN PITTSBURG.—New goods introduced to the trade; specialties placed with mills for manufacture; thoroughly reliable; bond furnished for any amount. LYDICK, 530 Sheridan Ave., Pittsburg, Pa.

WANTED.—Assistant Machine Shop Foreman by a concern manufacturing farm machinery; one who is thoroughly up-to-date and can produce results. Address box 310, care MACHINERY, 49 Lafayette St., New York.

WANTED.—Operators on Gleason Bevel Gear and Bilgram Gear Planers; Middle West. Address with particulars, box 311, care MACHINERY, 49 Lafayette St., New York.

WANTED.—A man to demonstrate and sell a small tool to machine shops; must have had some shop experience and some as salesman. Address THE WALTON CO., Hartford, Conn.

WANTED.—An experienced Pattern Shop Clerk, one who is capable of looking after detail Pattern Shop and Time Records. Answer stating age, experience and salary expected. Address CONFIDENTIAL, box 312, care MACHINERY, 49 Lafayette St., New York.

WANTED.—An experienced Stock Ledger man, one who has had considerable accounting experience and capable of taking entire charge of Stock Ledgers under the direction of the General Storekeeper. State age, experience and salary expected. Address CONFIDENTIAL, box 313, care MACHINERY, 49 Lafayette St., New York.

WANTED.—Draftsman, bright young man to take charge of a small drafting room. Address A. Z., care MACHINERY, 49 Lafayette St., New York.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00, cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—At once, a Mechanical Draftsman for detail work on cranes and electrical machinery. State salary and experience. SPRAGUE ELECTRIC CO., Bloomfield, N. J.

WANTED—SUPERINTENDENT-FOREMAN for machine shop. Experienced in heavy duty, commercial and gasoline engines. Must be good executive and able to produce results. Give full particulars. Address Box 298, care MACHINERY, 49 Lafayette St., New York.

WANTED—SHOP MANAGER for fabricating shop, handling about 25,000 tons of bars per annum. Technical graduate preferred. High-grade position. Only experienced men need apply. CORRUGATED BAR CO., Nat'l Bank of Commerce Bldg., St. Louis, Mo.

WE ARE INCREASING OUR FORCE and invite applications from machine hands of all kinds, including men who can turn multiple throw cranks, bench hands, erectors, metal polishers, and Jones & Lamson turret lathe hands. Shop located near Philadelphia and building marine gas engines. No labor troubles. Give experience in detail. Address box 293, care MACHINERY, 49 Lafayette St., New York.

WANTED—FIRST-CLASS MACHINISTS, steady work, good wages, nine hours. Write, giving reference, to UNITED METAL TRADES ASSOCIATION, 222 Commercial Club Bldg., Portland, Ore.

WANTED—First-class automobile draftsman with some executive ability, capable of directing 12 or 15 men. Address box 309, care MACHINERY, 49 Lafayette St., New York.

WANTED.—A-1 Cost Accountant, one experienced in Machine Shop, Foundry and Pattern Shop costs, and capable of handling help. Answer stating age, experience, salary expected and where at present employed. All answers treated confidential. Address CONFIDENTIAL, box 314, care MACHINERY, 49 Lafayette St., New York.